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CHESTERIAN (UPPER MISSISSIPPIAN) GASTROPODA OF THE ILLINOIS BASIN

MYINT LWIN THEIN
and
MATTHEW H. NITECKI

FEBRUARY 28, 1974

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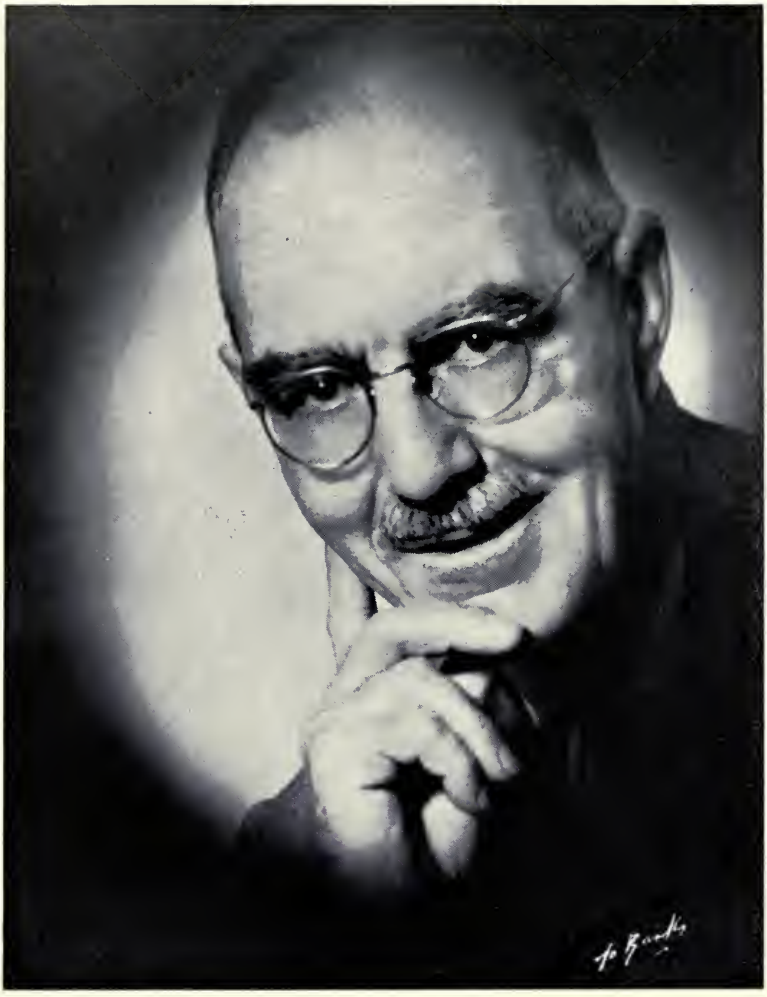

This volume is dedicated in gratitude and respect to
our friend and teacher,

PROFESSOR J. MARVIN WELLER,
geologist, stratigrapher, and paleontologist
on the occasion of his 75th birthday

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Geology

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CHESTERIAN (UPPER MISSISSIPPIAN) GASTROPODA OF THE ILLINOIS BASIN

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ABSTRACT

Chester gastropods from southern Illinois, eastern Missouri, and north-western Kentucky are described. The method used in discriminating the immature from adult individuals is explained. Fifty-three named species, 20 indetermined species and four variants are described. Four new genera are as follows:

Yochelsonospira
Wellergyi
Kinkaidia
Globozyga

Thirty-eight new species are as follows:

Bellerophon (Bellerophon) claxtonensis
B. (B.) menardensis
Knightites (Cymatospira) welleri
Patellilabia chesterensis
Straparollus (Euomphalus) illinoisensis
Trepospira (Trepospira) chesterensis
T. (Angyomphalus) kentuckiensis
Balyea okawensis
Euconospira sturgeoni
Neilsonia welleri
Wellergyi chesterensis
Yochelsonospira pagoda
Gosseletina johnsoni
Porcellia chesterensis
Glyptotomaria (Dictyotomaria) yochelsoni
Phymatopleura nyi
Kinkaidia cancellata
Strophostylus chesterensis
Naticopsis (Naticopsis) mariona
Aclisina golconda
A. marvinwelleri
Stegocoelia (Stegocoelia) kentuckiensis
S. (Stegocoelia) okawensis
S. (Hypergonia) baldwinensis
Platyzona americana
Eotrochus marigoldensis
Palaeozygopleura venusta
P. welleri
Bulimorpha minor
Leptoptygma golconda
Globozyga tenuistriata
Meekospira bambooformis
M. batteni
M. evansvillensis
M. mississippiensis
Donaldina marigoldensis
D. americana
D. zadoe

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SYMBOLS AND ABBREVIATIONS

The following symbols and abbreviations are used in the tabular material and in the text:

Corr. coeff.—correlation coefficient.
FMNH—Field Museum of Natural History.
H—height.
Ha—height of aperture.
Hf—height of final whorl.
Hs—height of spire.
L—length.
La—middle length of aperture.
La′—greatest length of aperture.
N—total number of specimens.
Ns—number of revolving or spiral ornaments.
Nw—number of whorls.
Pa—pleural angle.
Pw—number of whorls in protoconch.
S.D.—standard deviation.
S.E.(m)—standard error of the mean.
UC—University of Chicago.
W—greatest width.
Wa—width of aperture.
Wb—width at beginning of last whorl.
WM—Walker Museum of University of Chicago.
Ws—width of selenizone.
X—Worthen Collection, University of Illinois.

PART I

INTRODUCTION

The present paper is mainly a contribution to the systematic study of gastropods from rocks of the Chesterian Series (Upper Mississippian) of the southern part of the Illinois basin, that is the Upper Mississippi and Lower Ohio Valleys in Illinois, Western Kentucky, and Southeastern Missouri. This work deals only with the classification of lower taxa on the generic and specific levels and was undertaken for three reasons. First, very little has been published on the North American Late Mississippian gastropods and, therefore, a gap exists in the knowledge of gastropod evolution and distribution. Second, very few species have been known from the Chester Series which is the stratigraphic standard for the Upper Mississippian. Third, we have at our disposal a great collection of Chester snails collected by Stuart Weller and his students. Some of Weller's localities are no longer accessible and, in general, because of the size of the Chester organisms and the nature of the enclosing rock the fossils are very difficult to collect and few are available in most collections.

We are most grateful to Dr. Ellis L. Yochelson, United States Geological Survey, and Dr. J. Marvin Weller, University of Chicago, for reading and substantially improving the manuscript. Dr. Lois S. Kent, Illinois State Geological Survey, loaned the types of Meek and Worthen.

PREVIOUS WORKS

Part I of the *Treatise on Invertebrate Paleontology* is the most comprehensive general work on Paleozoic gastropods yet published (Knight et al., 1960). It supplements Knight's (1941) basic work, *Paleozoic Gastropod Genotypes*. Very few studies devoted especially to Late Mississippian gastropods in the United States have been undertaken. The most important are by Girty (1927), Elias (1958), and Yochelson and Dutro (1960). Sadlick and Nielson (1963) also published on some Late Mississippian pleurotomarians in a study of ontogenetic variation, in which they considered height or width of individual whorls alone. However, the rate of increase in one character alone is not regular during ontogeny, and, therefore, may not be significant biologically. Other scattered literature of interest includes Whitfield (1893), Meek and Worthen (1861, 1866a, 1873), Morse (1911), Snider (1915), J. M. Weller (1929a), Easton (1943, 1962), and Yochelson (1962, 1969a, b). Batten (1966) studied the Lower Carboniferous gastropods from England. The North American Pennsylvanian gastropods have been described recently by Sturgeon (1964a, b). Horowitz (1969) provided a complete listing of Chesterian type specimens from the Illinois Basin. Stuart Weller (1898) published a bibliographic index of North American carboniferous invertebtates that included bibliographic index of specific names of all Mississippian gastropods known to him. Yochelson and Saunders (1967) extended the index of specific names of gastropods through 1966.

GEOGRAPHIC DISTRIBUTION

The Chester formations of southern Illinois, eastern Missouri, and northwestern Kentucky occur in two distinctive areas. The first of these, which may be known as the northwestern area, begins in southern St. Claire County, Illinois, and continues across Monroe and Randolph Counties into Perry County, Missouri. Also included in this area is the whole development of the Chester west of the Mississippi River in Missouri and in Jackson County, Illinois. The second district in which the Chester formations are developed lies further south and may be spoken of as the southern area. It starts in the extreme southern portion of Jackson County, Illinois, and continues in a southeasterly and easterly direction across Johnson, Pope, and Hardin Counties. It then extends across the Ohio River into Livingston, Crittenden, Caldwell, and Christian Counties of western Kentucky.

The dividing line between these two areas may be somewhat arbitrarily taken as the Big Muddy River at the point where it cuts the Mississippi River bluffs. From this point northwestward the Chester formations are continuously exposed in the river bluffs and in the valleys tributary to the Mississippi, for a distance of about 42 miles. Further north, the Chester outcrops continue as a belt across Randolph and Monroe Counties, to the south portion of St. Claire County, separated from the river bluffs by an area of older Mississippian sediments. In southern St. Claire County the Chester formations again reach the Mississippi River bluffs for a short distance. The greatest width of this belt lies in southern Monroe and northern Randolph Counties. To the east the Chester formations are overlapped by the Pennsylvanian sediments, the overlap being greatest at the north, where only the very lowermost formations are exposed. In passing to the southeast, the Pennsylvanian sediments come into contact with higher and higher beds of the series; near the Big Muddy River they overlie the very highest of the formations of the series.

The southern Chester area in Illinois occupies a broad and shallow area, which extends from the Mississippi River bluffs of Grand

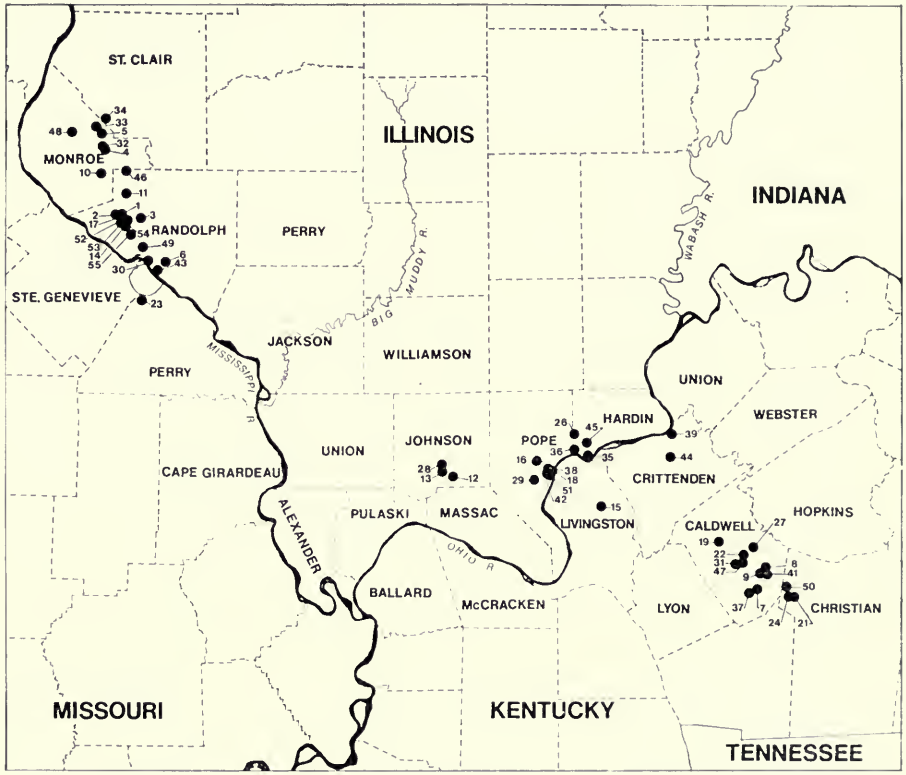

FIG. 1. Map of southern part of Illinois Basin showing the distribution of collecting localities. Localities 20, 25, and 40 not shown.

Tower, Illinois, to the southern part of the state in Hardin County. Our localities are found in Johnson, Pope, and Hardin Counties.

Most specimens described in this paper were collected predominantly from the Illinois portion of the Chester Series by Stuart Weller and his students. We have only one well-documented locality in Missouri, and 16 in Kentucky. Weller left detailed field notes and well marked topographic maps. We have endeavored to recollect from these localities; unfortunately, most sites are no longer accessible. As the result of our field work, we have attempted to place these localities on more modern maps. All but three localities are described in detail and are shown in Figure 1. The register of localities follows.

REGISTER OF LOCALITIES

Locality 1. Tributary to Camp Creek, NE¼, NE¼, sec. 17, T. 5S., R. 8W., 1¾ miles south of Ruma, Renault Quadrangle, Illinois. Locality W.M. 601. Lower part of Okaw (Golconda Group). Collected by Stuart Weller.

Straparollus (Euomphalus) planidorsatus

Locality 2. South branch of Camp Creek, near middle of north half of sec. 18, T. 5S., R. 8W., 2¾ miles southwest of Ruma, Renault Quadrangle, Illinois. Locality W.M. 594. Okaw Group. Collected by Stuart Weller, 1912 and 1913.

Euphemites randolphensis
Bellerophon (Bellerophon) chesterensis
Knightites (Retispira) ornatus
K. (Cymatospira) welleri
Patellilabia chesterensis
Straparollus (Euomphalus) planidorsatus
Yochelsonospira pagoda
Platyceras (Orthonychia) chesterense var. 1
P. (O.) chesterense var. 3
Eotrochus marigoldensis
Donaldina marigoldensis

Locality 3. Sinkhole quarry in east part of Evansville, between the railroad and the east-west county road, sec. 24, T. 5S., R. 8W., Baldwin Quadrangle, Illinois. Locality W.M. 626. Okaw Oolite member. Collected by Stewart Weller, 1913.

Knightites (Retispira) ornatus
Straparollus (Euomphalus) planidorsatus
Gosseletina johnsoni
Glyptotomaria (Dictyotomaria) yochelsoni
Platyceras (Orthonychia) chesterense var. 1
Strophostylus wortheni
Naticopsis (Naticopsis) waterlooensis
Stegocoelia (Stegocoelia) okawensis
S. (S.) baldwinensis
Eotrochus marigoldensis
Palaeozygopleura welleri
Meekospira bambooformis

M. evansvillensis
Donaldina marigoldensis
D. americana

Locality 4. Tributary of Rocky Branch, 3½ miles east of New Design, SE¼, NE¼, sec. 23, T. 3S., R. 9W., Waterloo Quadrangle, Illinois. Locality W.M. 604. Paint Creek Group. Collected by Stuart Weller.

Straparollus (Euomphalus) planidorsatus
S. (E.) sp. indet. 3

Locality 5. Near middle of east half of sec. 34, T. 2S., R. 9W., 4 miles east of Waterloo, Waterloo Quadrangle, Illinois. Locality W. M. 575. Renault Limestone. Collected by Stuart Weller.

Straparollus (Euomphalus) planidorsatus

Locality 6. Tributary of Gravel Creek SW¼, SW¼, sec. 35, T. 6S., R. 7W., 4 miles northwest of Chester, Chester Quadrangle, Illinois. Locality W.M. 628. Menard Limestone. Collected by Stuart Weller, 1913.

Bellerophon (B.) chesterensis
B. (B.) claxtonensis
B. (B.) menardensis
Patellilabia chesterensis
Straparollus (Euomphalus) illinoisensis

Locality 7. One and one-fourth miles northeast of Otter Pond, along dirt road heading southeast from the 541 BM at 550-ft. elevation. Princeton East Quadrangle, Kentucky. Locality W.M. KP 35. Renault Limestone. Collected by Stuart Weller, 1921.

Straparollus (Euomphalus) sp. indet. 1
Platyceras (Orthonychia) chesterense var. 1

Locality 8. Three-fourths mile west of Claxton on south of stream, about equal distance between Illinois Central R. R. and Claxton-Beulah Hill Church, at 500-ft. elevation, on north side of hill. Princeton East Quadrangle, Kentucky. Locality W.M. KP 51. Kinkaid Limestone. Collected by Stuart Weller, 1921.

Straparollus (Euomphalus) sp. indet. 1

Locality 9. One and one-fourth miles southwest of Claxton, at 570-ft. elevation, on southwest side of hill, 4,000 ft. east of BM 544. Princeton East Quadrangle, Kentucky. Locality W.M. KP 49. Golconda Group. Collected by Stuart Weller, 1921.

Euphemites randolphensis
Bellerophon (Bellerophon) claxtonensis
Knightites (Retispira) ornatus
K. (Cymatospira) welleri
Straparollus (Euomphalus) sp. indet. 1
Wellergyi chesterensis
Gosseletina johnsoni
Borestus cf. *B. chesterensis*
Phymatopleura nyi
Platyceras (Orthonychia) chesterense var. 1
Strophostylus wortheni
S. chesterensis
Aclisina golconda
A. marvinwelleri
Stegocoelia (Stegocoelia) kentuckiensis
Platyzona americana
Palaeostylus (Stephanozyga) sp. indet. 1
P. (Stephanozyga) sp. indet. 2
Ianthinopsis littonana
I. cf. *I. paludinaeformis*
Meekospira evansvillensis
M. minuta
M. mississippiensis
Donaldina zadoe

Locality 10. Four miles west of Redbud, SW¼, SW¼, sec. 2, T. 4S., R. 9W., Renault Quadrangle, Illinois. Locality W.M. 603. Oolitic member of Renault Limestone. Collected by Stuart Weller, 1912.

Euphemites randolphensis
Knightites (Retispira) ornatus
Platyceras (Orthonychia) chesterense var. 1
P. (O.) chesterense var. 2

Locality 11. One and one-half miles northeast of Ruma, SE¼, SE¼, sec. 28, T. 4S., R. 8W., Baldwin Quadrangle, Illinois. Locality W.M. 620. Lower Okaw Group. Collected by Stuart Weller, 1913.

Euphemites randolphensis
Knightites (Cymatospira) welleri
Platyceras (Orthonychia) chesterense var. 1
P. (O.) chesterense var. 3
Eotrochus marigoldensis

Locality 12. Eight miles southwest of Vienna, north side of creek, at 400-ft. elevation. NW¼, SW¼, sec. 17, T. 13S., R. 4E., Vienna Quadrangle, Illinois. Locality W.M. 18–29. Glen Dean Limestone. Collected by Stuart Weller, 1918.

Bellerophon (Bellerophon) chesterensis
Knightites (Cymatospira) welleri
Patellilabia chesterensis
Euconospira sturgeoni
Porcellia chesterensis
Borestus chesterensis
Lepetopsis chesterensis
Platyceras (Platyceras) subrotundum
P. (Orthonychia) chesterense var. 1
P. (O.) chesterense var. 2
Naticopsis (Naticopsis) sp. indet.
Platyzona sp. indet. 2

Locality 13. Three and one-half miles southeast of Vienna, north of Cave Creek, 0.6 mile north of Berea School, SE¼, sec. 22, T. 13S., R. 3E., Vienna Quadrangle, Illinois. Locality W.M. 18–25, basal part of Golconda. Collected by Stuart Weller, 1918.

Euphemites randolphensis
Bellerophon (Bellerophon) chesterensis
Knightites (Retispira) ornatus
Trepospira (Trepospira) chesterensis
Mourlonia sp. indet.
Phymatopleura sp.
Lepetopsis sp. indet.
Leptoptygma golconda

Locality 14. Along the stream and dirt road, 1½ miles south of Marigold, SW¼, SE¼, sec. 29, T. 5S., R. 8W., Renault Quadrangle, Illinois. Locality W.M. 597. Marigold Oolite (Haney Limestone). Collected by Stuart Weller, 1912.

Knightites (Retispira) ornatus
K. (Cymatospira) welleri
Straparollus (Euomphalus) sp. indet. 4
S. (Straparollus) sp. indet.
Baylea okawensis
Euconospira sp. indet. 3
Neilsonia welleri
Gosseletina johnsoni
Porcellia chesterensis
Glyptotomaria (Dictyotomaria) yochelsoni
Platyceras (Orthonychia) chesterense var. 3
Strophostylus wortheni
Naticopsis (Naticopsis) waterlooensis
Aclisina marvinwelleri
Stegocoelia (Stegocoelia) okawensis
Eotrochus marigoldensis
Palaeozygopleura venusta
P. welleri
P. cf. *P. yandellana*
P. wortheni
Bullimorpha minor
Globozyga tenuistriata
Soleniscus sp. indet.
Meekospira bambooformis

M. batteni
M. evansvillensis
Girtyspira canaliculata
Donaldina marigoldensis
D. americana

Locality 15. Decomposed layers of very siliceous limestone near the bottom of the formation, exposed in the floor of the nearly straight, narrow, north-south valley tributary to Deer Creek from the south, whose mouth is situated nearly one-half mile northwest of the junction point of two widely diverging, terminal branches of the stream. The locality is at the western apex of an imaginary equilateral triangle, with other apexes of Old Salem School and Livingston School. Three and one-fourth miles south of Lola. Golconda Quadrangle, Kentucky. Locality W.M. GK 12. Glen Dean Limestone. Collected by Stuart Weller, 1920.

Patellilabia chesterensis
Borestus chesterensis
Platyceras (*Orthonychia*) *chesterense* var. 3

Locality 16. Two-hundred-fifty feet south from dirt road, SE¼, NW¼, sec. 10, T. 13S., R. 6E., 2 miles northeast of Waltersburg, Brownfield Quadrangle, Illinois. Locality W.M. 16–5. Kinkaid Limestone. Collected by Stuart Weller, 1916.

Straparollus (*Euomphalus*) sp. indet. 2

Locality 17. Tributary of Camp Creek, 1 mile northwest of Marigold, NW¼, NW¼, sec. 20, T. 5S., R. 8W., Renault Quadrangle, Illinois. Locality W.M. 595. Okaw Group. Collected by Stuart Weller, 1912.

Straparollus (*Euomphalus*) sp. indet. 5
Platyceras (*Orthonychia*) *chesterense* var. 4

Locality 18. Ohio River Bluffs, near Golconda, Golconda Quadrangle, Illinois. Chaney locality 14. Golconda Group. Collected by R. W. Chaney.

Trepospira (*Trepospira*) *chesterensis*
Platyceras (*Orthonychia*) *chesterense* var. 2
P. (*Orthonychia*) *chesterense* var. 3

Locality 19. Three and three-tenths miles northeast of Crider, about equal distance south of Farmersville, west side of Donaldson Creek at 500-ft. elevation, Crider Quadrangle, Kentucky. Locality W.M. KP-60. Paint Creek Group. Collected by Stuart Weller, 1921.

Trepospira (*Angyomphalus*) *kentuckiensis*

Locality 20. Southern part of Dawson Springs Quadrangle, Kentucky. Glen Dean Limestone. Collected by A. H. Sutton, 1926. Sutton (1930) describes five collecting sites from this general area. However, we are not able to pinpoint this locality exactly.

Mourlinia angulata
Euconospira cf. *E. sturgeoni*

Locality 21. One and one-fourth miles north of Bainbridge Church, a small glade-like exposure west of road, Christian County, Dawson Springs Quadrangle, Kentucky. Golconda Group. Collected by A. H. Sutton, 1926.

Euconospira sp. indet. 1

Locality 22. About 60–70 ft. above flood plain of Wiley Creek at approximately 470-ft. elevation, south of Davis Bluff. Three and one-half miles northeast of Princeton, 87° 45′ 50″ west and 37° 09′ north, Olney Quadrangle, Kentucky. Locality KP 23. Golconda Group. Collected by Stuart Weller, 1921.

Euconospira sp. indet. 2

Locality 23. West bluff of the Mississippi River, above highway and railroad tracks. One mile northwest of Perryville Junction, Perry County, Missouri, Chester Quadrangle, Illinois-Missouri. Lower part of Okaw. Collected by Stuart Weller, 1926.

Gosseletina johnsoni
Porcellia chesterensis
Platyzona sp. indet. 1

Locality 24. Two and one-fourth miles northwest of Bainbridge Church, along road southwest from Princeton Pike, Christian County, Dawson Spring Quadrangle, Kentucky. Paint Creek Group. Collected by A. H. Sutton, 1926.

Porcellia chesterensis

Locality 25. Rizer's Landing. Chester Series, Missouri. Gurley Collection.

Porcellia chesterensis

Locality 26. South side of hill at 480-ft. elevation, west side of State Highway 34, one-half mile south of Eichorn, Illinois. SE¼, SW¼, sec. 11, R. 6E., T. 12S., Golconda Quadrangle, Kentucky-Illinois. Locality W.M. 17-1. Shetlerville bed of Renault Limestone. Collected by Stuart Weller, 1917.

Borestus chesterensis
Platyceras (Orthonychia) chesterense var. 1

Locality 27. One thousand feet directly east of end of jeep road on east side of Sugar Creek and west of Sells Hollow. This is a southwestern slope of Goodaker Ridge, at 480-ft. elevation, about 6 miles northwest of Princeton. Olney Quadrangle, Kentucky. Locality W.M. KP 24. Kinkaid Limestone. Collected by Stuart Weller, 1921. On 1910 map of Princeton Quadrangle there is a dirt road cutting across this locality. The 1967 map of Olney Quadrangle does not show any road.

Kinkaidia cancellata

Locality 28. Two and one-half miles southeast of Vienna, north of Cave Creek, sec. 15, R. 3E., T. 13S., Mermet Quadrangle, Illinois. Locality W.M. 18-28. Glen Dean Limestone. Collected by Stuart Weller, 1918.

Platyceras (*Platyceras*) *subrotundum*

Locality 29. One and three-fourths miles north of Homberg, SW¼, SW¼, sec. 27, R. 6E., T. 13S., Brownfield Quadrangle, Illinois. Locality W.M. 16-3. Glen Dean Limestone. Collected by Stuart Weller, 1916.

Platyceras (*Platyceras*) *subrotundum*

Locality 30. One hundred twenty ft. above railroad track in Fort Gage, sec. 32, R. 7W., T. 6S., Chester Quadrangle, Illinois. Locality W.M. 212. Lower part of Okaw (Golconda Group). Collected by Stuart Weller, 1907.

Platyceras (*Platyceras*) sp. indet. 1
P. (*O.*) *chesterense* var. 1
P. (*O.*) *chesterense* var. 3

Locality 31. About one-half mile northeast of Princeton, along unnumbered road situated between US Highway 62 and Kentucky Highway 293. Southwestern corner of Princeton East Quadrangle, Kentucky. Locality W.M. KP 25. Renault Limestone. Collected by Stuart Weller, 1921.

Platyceras (*Platyceras*) sp. indet. 2

Locality 32. Seven miles southeast of Waterloo, 3½ miles east of New Design (Burkesville Station) along the southeastern branch of the unnamed tributary to Rockhouse Creek. NE¼, SE¼, sec. 14, T. 3S., R. 9W., Paderborn Quadrangle, Illinois. Locality W.M. 565. Paint Creek Group. Collected by Stuart Weller, 1911.

Platyceras (*Orthonychia*) *chesterense* var. 1

Locality 33. Three miles east of Waterloo, on gravel road just west of bridge across Walters Creek. Middle of west half of north line of sec. 27, T. 2S., R. 9W., Paderborn Quadrangle, Illinois. Locality W.M. 568. Renault Limestone. Collected by Stuart Weller, 1911. The road going south from this locality, as shown on 1913 map of Waterloo Quadrangle, is not shown on Paderborn Quadrangle, 1968 edition.

Platyceras (Orthonychia) chesterense var. 1

Locality 34. One and one-half miles northwest of Floraville, just north of bridge across Prairie du Long Creek. NW¼, NE¼, sec. 10, T. 2S., R. 9W., Milstadt Quadrangle, Illinois. Locality W.M. 567. Paint Creek Group. Collected by Stuart Weller, 1911.

Platyceras (Orthonychia) chesterense var. 1
P. (O.) chesterense var. 4

Locality 35. Below Rosiclare at base of Fairview Bluff (the southwestern bluff) just above water at approximately 400-ft. elevation. Sec. 5, T. 13S., R. 8E., Rosiclare Quadrangle, Illinois. Locality W.M. 327. Shetlerville bed of Renault Limestone. Collected by Stuart Weller. The Golconda Quadrangle map, 1921 edition, shows a railroad spur below this locality and above the river, however, the 1959 Rosiclare Quadrangle map does not show the railroad.

Platyceras (Orthonychia) chesterense var. 1

Locality 36. Southwestern base of Lower Melcher Hill, between Melcher Hills and Rich Hill. SW¼, NE¼, sec. 35, T. 12S., R. 7E., Shetlerville Quadrangle, Illinois. Locality W.M. 328. Shetlerville bed of Renault Limestone. Collected by Stuart Weller, 1907. The 1921 Golconda Quadrangle map shows a road just south of the locality, between Melcher and Rich Hills. The 1959 edition of Shetlerville Quadrangle map does not show this road.

Platyceras (Orthonychia) chesterense var. 1

Locality 37. Southwest base of hill just past the Otter Ponds, about 0.6 mile northeast of village of Otter Pond, along the gravel road from this village to Dripping Spring. Princeton East Quadrangle, Kentucky. Locality W.M. KP 33. Renault Limestone. Collected by Stuart Weller, 1921.

Platyceras (Orthonychia) chesterense var. 1
P. (O.) chesterense var. 2

Locality 38. Ohio River Bluffs, north of Golconda, Golconda Quadrangle, Illinois. Chaney Locality no. 1. Golconda Group.

Collected by R. W. Chaney.

Platyceras (*Orthonychia*) *chesterense* var. 1

Locality 39. Bluffs of Camp Creek in Weston, Repton Quadrangle, Kentucky. Locality W.M. KC 2. Top of Golconda (Haney Formation). Collected by Stuart Weller, 1923.

Platyceras (*Orthonychia*) *chesterense* var. 1

Locality 40. Pope County, Illinois. Probably Golconda Group. Worthen Collection in University of Illinois Collection, Urbana, Illinois.

Platyceras (*Orthonychia*) *chesterense* var. 2

Locality 41. West side of Eison Branch of Montgomery Creek, 600 ft. north of State Highway 278, 2 miles east of Bald Knob, 1.4 miles southeast of Claxton, Princeton East Quadrangle, Kentucky. Locality W.M. KP 46. Shale member of Paint Creek Group. Collected by Stuart Weller, 1921.

Platyceras (*Orthonychia*) *chesterense* var. 2

Locality 42. Near Golconda, Golconda Quadrangle, Illinois. R. W. Chaney locality 2. Golconda Group. Collected by R. W. Chaney.

Platyceras (*Orthonychia*) *chesterense* var. 3

Locality 43. About equal distance between Menard and Fort Gage, along the Mississippi River bluffs, above the railroad tracks. Chester Quadrangle, Illinois. Locality W.M. 216. Glen Dean Limestone. Collected by Stuart Weller, 1907.

Platyceras (*Orthonychia*) *chesterense* var. 4

Locality 44. Between Turkey Knob and unnamed hill southeast from it, at the end of dirt road, approximately 5 miles north of Marion, Repton Quadrangle, Kentucky. Locality W.M. KC 46. Golconda Group. Collected by Stuart Weller, 1923.

Naticopsis (*Naticopsis*) *mariona*

Locality 45. Three miles northwest of Rosiclare along the Three-mile Creek, NE¼, NW¼, sec. 30, T. 12S., R. 8E., Rosiclare Quadrangle, Illinois. Locality W.M. 15-10. Kinkaid Limestone. Collected by Stuart Weller, 1915.

Naticopsis (*Naticopsis*) *mariona*

Locality 46. City Quarry of Redbud, operating for road material in the east bank of the creek just north of the Redbud-Waterloo road leading west from the city. Eight to 12 ft. of blue, crystalline limestone with some shaly partings are exposed. This limestone is near the base of the formation and is highly fossiliferous. Sec. 5, T. 3S., R. 8W., Renault Quadrangle, Illinois. Locality W.M. 253. Lower part of Okaw (Golconda Group). Collected by Stuart Weller, 1907.

Naticopsis (Naticopsis) suturicompta

Locality 47. At 520-ft. elevation, 400 ft. west of Ward Creek; 2,500 ft. south from electric line; 5,000 ft. northeast of Walche Cut on Illinois Central Railroad; 2 miles northeast of Scottsburg. Princeton East Quadrangle, Kentucky. Locality W.M. KP 14. Glen Dean Limestone. Collected by Stuart Weller, 1921.

Naticopsis (Naticopsis) suturicompta

Locality 48. In a rock gorge just above the bridge of state Route 156, over Fountain Creek, as shown on Waterloo Quadrangle map of 1913 (or just under or slightly below the bridge as shown on 1954 map), 2 miles southwest of Waterloo. SW¼, sec. 27, T. 2S., R. 10W., Waterloo Quadrangle, Illinois. Ste. Genevieve Limestone. Collected by Stuart Weller, 1906.

Strophostylus wortheni
Naticopsis (Naticopsis) waterlooensis
Palaeozygopleura wortheni

Locality 49. One and one half miles southwest of Ellis Grove in Moccasin Hollow; 0.9 mile northeast of Illinois Southern Railroad tracks; about equal distance between two dirt roads, sec. 24, R. 8W., T. 6S., Baldwin Quadrangle, Illinois. Locality W.M. 615. Okaw Group (Oolite member). Collected by Stuart Weller, 1913.

Naticopsis (Naticopsis) saturicompta
N. (N.) waterlooensis
Stegocoelia (Stegocoelia) okawensis
Palaeozygopleura welleri
Bullimorpha minor
Meekospira bambooformis
Donaldina americana

Locality 50. Three-fourth mile north of Bainbridge Church, bounded by faults 37, 38, 39, and 40 on hill, west side of State Route 398, between Bainbridge and Hawkins, 400 ft. south of junction with two dead-end unpaved roads; Dawson Springs, S.W. Quadrangle, Kentucky. Golconda Group. Collected by A. H. Sutton, 1926.

Aclisina marvinwelleri

Locality 51. Cement Quarry northwest of Golconda, sec. 24, T. 13S., R. 6E., Golconda Quadrangle, Illinois. Golconda Group. Collected by H. N. Toler.

Globozyga tenuistriata

Locality 52. Between creek and dirt road, north of sinkholes, one-half mile south of Marigold. NW¼, NE¼, sec. 29, T. 5S., R. 8W., Renault Quadrangle, Illinois. Locality W.M. 596. Marigold Oolite (Haney Limestone).

Locality 53. South side of dirt road, 0.9 mile south of Locality 52, 1½ miles south of Marigold. SE¼, SW¼, sec. 29, T. 5S., R. 8W., Renault Quadrangle, Illinois. Locality W.M. 598. Marigold Oolite (Haney Limestone).

Locality 54. Dirt road and the last southern tributary of Crooked Creek at 482-ft. elevation, three-fourths mile south of Phegley School, T. 5S., R. 8W., Bladwin Quadrangle, Illinois. Locality W.M. 599. Marigold Oolite (Haney Limestone).

Locality 55. In bank of creek tributary to Kaskakia River, just east of last junction of two creeks, south of sinkholes, 100 ft. east of Roots-Phegley School dirt road, 1¼ miles northwest of Roots, T. 5S., R. 8W., Baldwin Quadrangle, Illinois. Locality W.M. 616. Marigold Oolite (Haney Limestone).

STRATIGRAPHY

The name Chester was introduced by Worthen in 1860 for alternating sandy and limy strata overlain by dominantly clastic Pennsylvanian rocks and underlain by the main succession of Mississippian limestones in the Illinois region. Ulrich made the first systematic subdivision of the succession in 1905 and 1922, and Stuart Weller established a complete column of formational units in 1913. Further works bearing on the nature and classification of these rocks are, in Illinois, S. Weller (1920a, b), and Sutton (1934); in Kentucky, Butts (1918a), S. Weller (1921), and Sutton (1930); and in Indiana, Malott (1925, 1952) and Cumings (1922). Stuart Weller's fundamental work on Chester published from 1922 to 1951 (S. Weller, 1922, 1923, 1926a, b, 1927a, b, S. Weller and Krey, 1939, and S. Weller and Sutton, 1951) formed the basis of more recent synthesis. Lower Chester of Kentucky and Illinois was studied by Sutton and J. M. Weller (1932). A general summary was given by J. M. Weller and Sutton in 1940, and a broader consideration was presented by J. M. Weller et al. in 1948. Swann (1963) revised the Chester section again mainly in the light of subsurface studies, especially those by Dana and Scobey (1941), and Swann and Atherton (1948). The revised classification by Swann is shown in Table 1.

Three stratigraphic units used in this paper are not shown in Table 1. These are Evansville, Marigold, and Shetlerville. Evansville Oolite is an unnamed unit found in Locality 3. This locality is in the eastern part of the city of Evansville, Illinois, where a number of sink holes are present, in which the limestone is exposed, and in one a quarry has been opened to furnish rock for local use. The rock is a white oolite, probably the same bed as that exposed south of Marigold, Randolph County, Illinois.

Marigold Oolite is the term used extensively by Stuart Weller in his field notes and in his unpublished manuscripts. Sutton (1934) considered Marigold Oolite to be a zone of Lower Okaw and Swann (1963) assigned it a rank of a bed in the Haney Limestone. The type section of this unit is south of Marigold, in the three heads of Crooked Creek, a tributary of the Okaw River, and consists of good

SERIES	STAGES	FORMATIONS	GROUPS W	GROUPS E
Chesterian	Elviran	Grove Church		
		Kinkaid		
		Degonia		
		Clore		
		Palestine		
		Menard		
		Waltersburg		
		Vienna		
		Tar Spring		
	Hombergian	Glen Dean	Okaw	
		Hardingsburg		
		Haney		Golconda
		Fraileys		
	Gasperian	Beech Creek		
		Cypress		West Baden
		Ridenhower	Paint Creek	
		Bethel		
		Downeys Bluff		Cedar Bluff
		Yankeetown		
		Renault		
Valmeyeran	Genevievian	Aux Vaxes		
		Ste. Genevieve		

TABLE 1. Stratigraphic chart of Upper Mississippian rocks of Illinois. Somewhat modified from Swann, 1963.

exposures of a conspicuous oolite bed, some 50 or 60 ft. above the base. The unit is well developed in Localities 14 and 52–55.

Shetlerville bed, or member, Stuart Weller (1920b) originally described as a formation and later, in his field notes considered it a basal shaly part of Renault formation. Swann (1963) formally restricted the term Shetlerville to the limestone and associated shale and sandstone of earliest Gasperian age, and to a member of Renault Formation.

The sedimentology of Chesterian sandstones has been studied by Potter and Siever (1955), Potter et al. (1958), and Potter (1962). The Chesterian carbonates have been analyzed by Carozzi and Roche (1968).

METHODS

Qualitative treatment is the main process in discriminating species within a genus when only very small samples are available. In larger collections, quantitive treatment may supplement the usual qualitative approach.

Most measurements, except those of individual whorl width and height were made without a point of reference on the shell and as close to the oldest portion of the shell as possible. Specimens were oriented so that the axis of coiling was approximately perpendicular to the line of vision. In measuring the pleural angle, the specimens were fixed firmly with clay on a white card and two tangents were drawn with a straightedge touching the sides of the two oldest whorls. The pleural angle so obtained is more precise than that obtained by using a cardboard goniometer, especially with small specimens. This method also avoids the problems involved, if the arms of goniometer do not touch the whorls properly.

If biologically significant, measurements were made whenever possible. They were matched with the qualitative characters ordinarily used to distinguish species within genera. If specimens were sufficiently abundant, the measurements were treated statistically to discriminate between closely related species. Reduced major axes were drawn to indicate relative growth. A detailed method of using reduced major axes has been explained by Imbrie (1956).

Holotypes only are recognized as valid types; all other so called primary and secondary types are listed as referred or illustrated specimens.

Photographs were made of specimens typical for the species, and others showing individual or ontogenetic variations. The specimens were whitened with magnesium oxide, and the photographs were not retouched. Sections to be photographed were moistened with thin cooking oil.

The morphological terms applied to gastropod shells are often difficult to follow. In our descriptions of figures we have used only the following terminology: anterior, apertural, apical, dorsal, lateral, left, oblique, posterior, right, umbilical, and ventral.

GROWTH CURVES OF TINY GASTROPODS

A problem that is not infrequent in paleontology is posed by the need to decide whether a small sample of a fossil species consists of mature specimens or immature individuals selectively sorted as to their size. Uncertainty is particularly likely if the specimens are much smaller than closely similar specimens or representatives of related species. We faced this problem in connection with our study of Chesterian gastropods.

Most organisms grow at a rate that, on the basis of relatively increasing size, steadily and somewhat regularly decreases with the passage of time, as shown by the generalized curve in Figure 2. This relationship is of little service in paleontology because, the time factor being unknown, growth cannot be plotted against it. The actual age at any stage of growth is indeterminable for fossils, although the relative age of gastropods is indicated by the number of their whorls.

Growth can be graphed in another way, as shown in Figure 3. Here the actual size of specimens rather than relative growth rate is plotted against time. Like the other, this curve has little paleontologic application because time cannot be adequately calibrated.

Both of these curves are of the sigmoidal type and this form seems to be typical of many curves depicting growth. Such curves consist of three segments: first, as seen in Figure 3, is a segment that is concave upward and identifies a juvenile stage. Relative growth here is rapid but, because individuals are small, actual increase in size is slight. The second segment rises in a nearly straight line and represents the adolescent stage. Although relative growth declines, actual size progresses at an increasing rate. Finally, the attainment of maturity is indicated by the third segment which is convex upward and passes into a line approaching horizontality. At this point, both relative and actual growth decrease.

Plotting simple measurements of the fossil gastropods against the successive whorls, as a substitute for time, produced more or less sigmoidal curves (see figs. 4, 5). These, however, do not show clearly the threefold division already mentioned. Experience demonstrates that the ratios of certain selected related characters produce curves

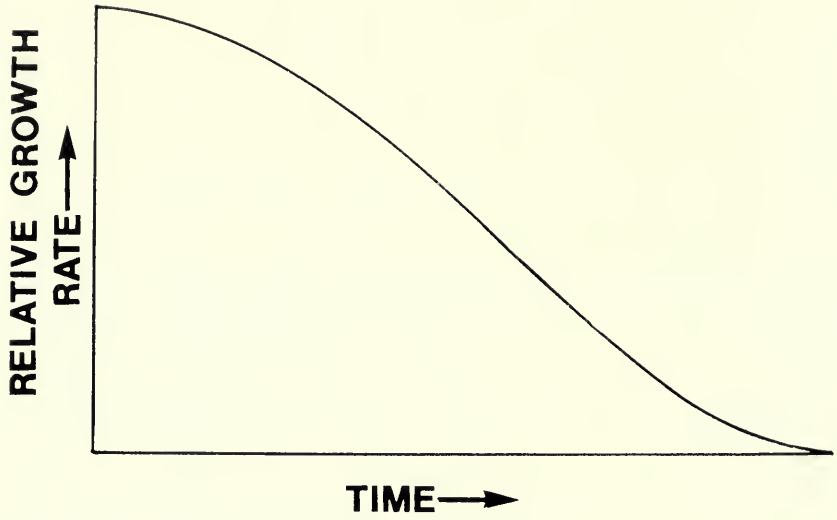

FIG. 2. Generalized curve showing how the relative growth rate of most organisms decreases with time.

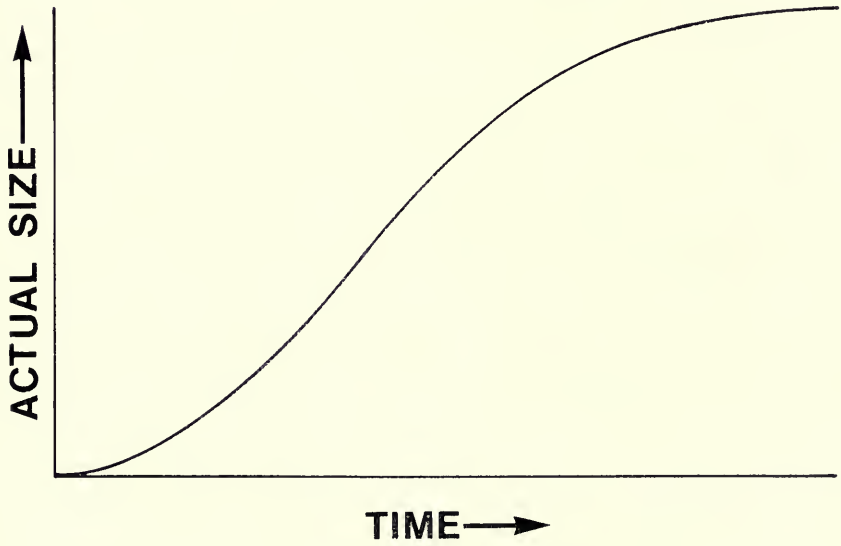

FIG. 3. Generalized curve showing how the actual size of most organisms increases with time.

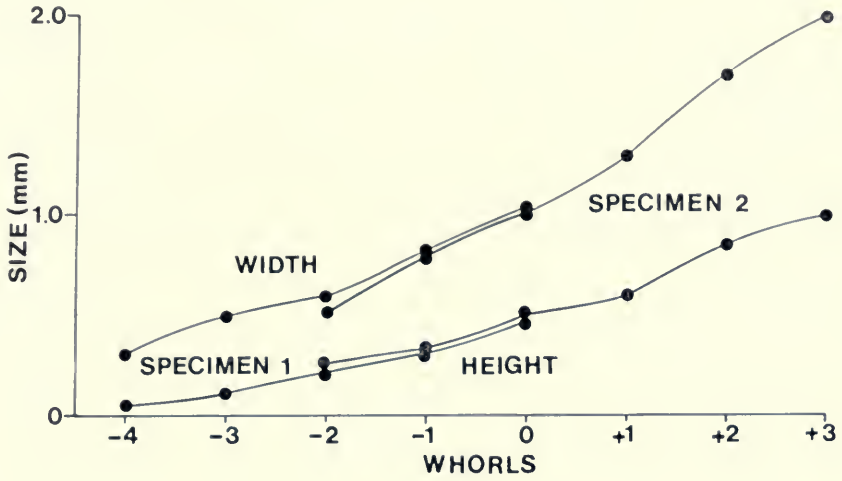

FIG. 4. Graph showing increasing size of two specimens of *Stegocoelia* (*Stegocoelia*) *okawensis* n. sp. plotted against successive whorls as explained in text. Compare with Figure 5.

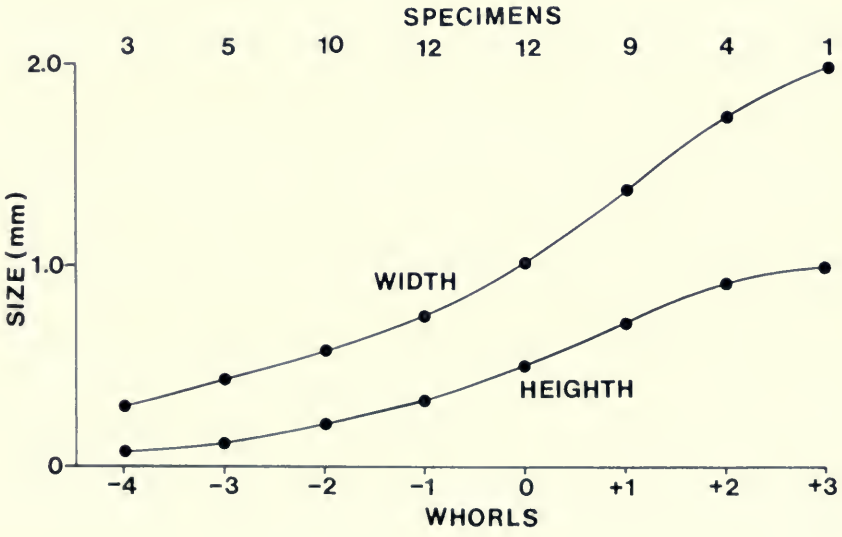

FIG. 5. Curves showing average height and width of whorls in 12 specimens of *Stegocoelia* (*Stegocoelia*) *okawensis* n. sp. Numbers at top show number of specimens whose measurements were averaged for each whorl.

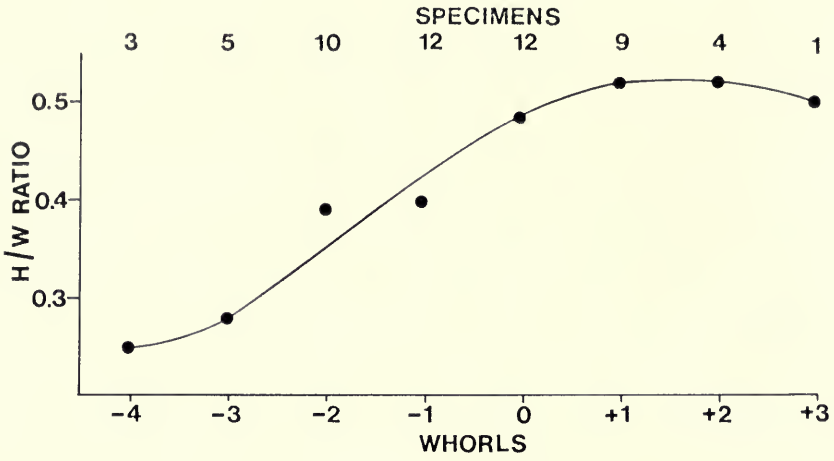

FIG. 6. Curve showing average height to width ratio of 12 specimens of *Stegocoelia* (*Stegocoelia*) *okawensis* n. sp.

that appear to be more satisfactorally interpreted (see figs. 6–9). These seem to make possible the differentiation of the specimens of small species from immature segregated specimens.

The method used in the study and comparison of the tiny gastropods utilizes the ratio of the height-to-width of successive whorls.

No two specimens are entirely similar and no single specimen can be relied upon to characterize a species satisfactorally. Consequently, it is advantageous to construct growth curves and base conclusions on the average measurements of specimens in a sample. The resulting curves, although generalized, are likely to be more regular and in other ways superior as the basis for interpretation (compare figs. 4, 5).

The desire to average measurements introduces another problem. If the fossils were all perfectly preserved, successive whorls from the first one onward could be measured and averaged in order. More often than not, however, the apex of a fossil gastropod has been damaged or broken away so that no common starting point in whorl-counting is provided. This difficulty was overcome by establishing an arbitrary zero point where whorl height attains some convenient dimension, such as 0.5 or 1.0 mm. This whorl was designated 0. Subsequent whorls were numbered +1, +2, +3, etc., and preceding whorls were identified as −1, −2, −3, etc. The whorls of similar number were then averaged.

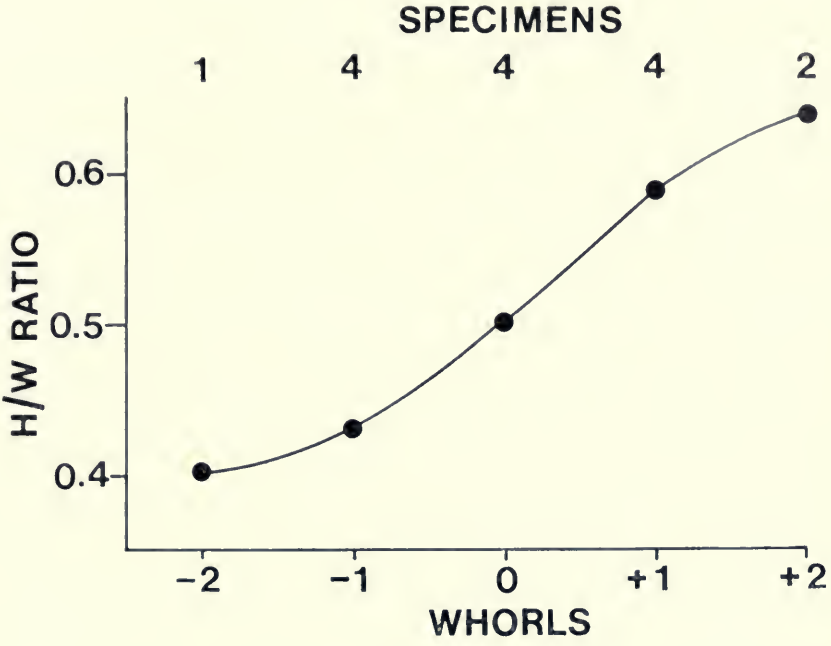

FIG. 7. Curve showing average height to width ratio of four specimens of *Bulimorpha minor* n. sp.

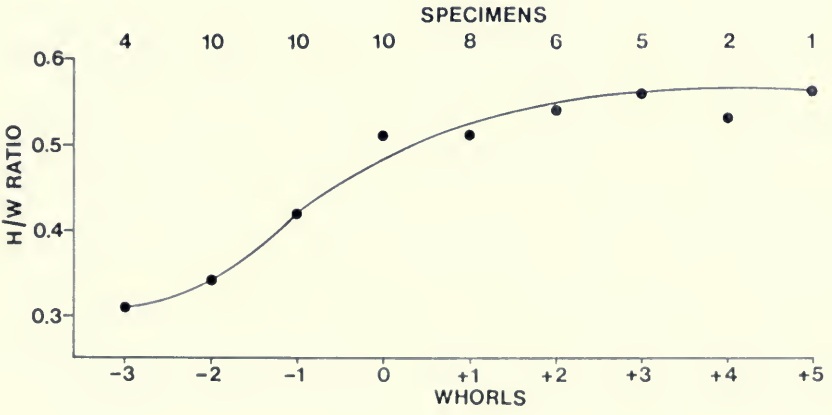

FIG. 8. Curve showing average height to width ratio of 10 specimens of *Meekospira batteni* n. sp.

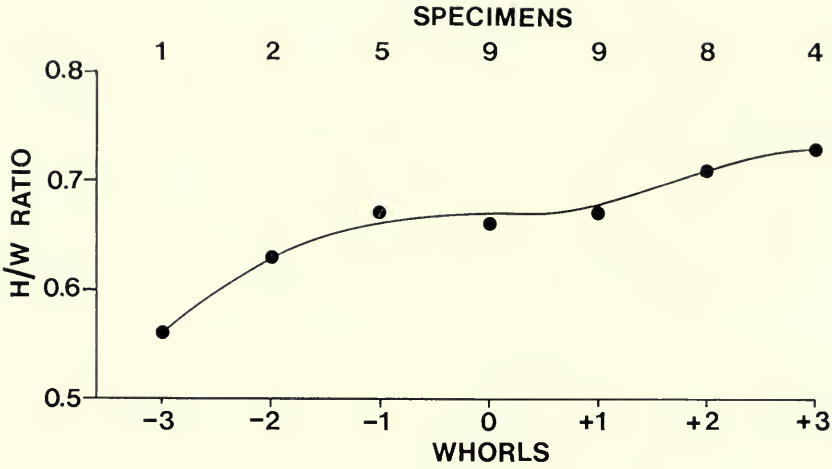

FIG. 9. Curve showing average height to width ratio of nine specimens of *Meekospira mississippiensis* n. sp.

Measurements were made under a binocular microscope with dividers adjusted with a screw and a vernier caliper accurate to 0.1 mm. Estimates were made to 0.01 mm. All specimens in a single lot were measured at one sitting to minimize bias that might otherwise have been introduced.

Measurements were made and curves drawn for 13 species of small gastropods. Four of the more characteristic and satisfactory graphs are presented here. The remaining graphs are discussed in "Part II, Systematic Descriptions." Figure 6, based on 12 specimens of *Stegocoelia* (*Stegocoelia*) *okawensis* n. sp. shows the three growth stages clearly. Figure 7 is based on four individuals of *Bulimorpha minor* n. sp. Fully mature specimens seem to be lacking. Figure 8 is based on ten shells of *Meekospira batteni* n. sp. Evidently included here are a few older specimens that seem to have approached senility. Figure 9, based on nine specimens of *Meekospira mississippiensis* n. sp., shows terminal irregularity that may indicate the presence of distorted senile individuals.

Carefully selected growth curves of fossil gastropods seem to provide the means for recognizing the principal growth stages of these animals and for identifying specimens that had reached maturity. The succession of whorls is ideal as the indication of relative age. Because of this, gastropod shells are interpreted more satisfactorily than the remains of most other kinds of animals. Nevertheless, ingenuity may help to discover how somewhat similar treatment can be applied to other types of fossils.

RELATIONSHIPS OF THE CHESTER GASTROPODS

The Upper Mississippian gastropods reported here total 82 forms, including 53 named, five forms closely related to named species, 20 indeterminate species, and four variants. Of the 53 named species, 38 are new. Thirty-five genera are recognized of which four *Globozyga*, *Kinkaidia*, *Wellergyi*, and *Yochelsonospira* are new.

The chief characteristic of the gastropods from the Chester Series is their overwhelming affinity to Middle Mississippian forms, especially those of the Salem Limestone of Indiana and the Ste. Genevieve Limestone of Illinois. This probably results from the presence of 30 minute forms which occur in oolitic limestone that has environmental implications similar to the Salem and Ste. Genevieve Limestones.

Several of the Chester gastropods belong to genera and subgenera which seem to be restricted to beds no younger than the Mississippian. Thus, *Platyceras* (*Platyceras*) ranges from the Silurian to the close of the Mississippian, *Palaeozygopleura* from the Devonian to the Upper Mississippian (Coal Measures in Europe, Batten, 1966, p. 84), *Trepospira* (*Angyomphalus*) reported only from the Lower Carboniferous of Europe and the Upper and Middle Mississippian of North American continent, and *Eotrochus* and *Bulimorpha* known only from the Mississippian and "Carboniferous." *Eotrochus* sp. has recently been reported from the Redwall Limestone of Arizona (Yochelson, 1969a, pl. 60, fig. 6). Furthermore, *Aclisina* is mainly restricted to the Lower Carboniferous of Europe, north central Asia, and North America. All new genera with the exception of *Wellergyi* reported in this paper have not been recognized outside of the Mississippian.

Comparisons with the Upper Mississippian species from other areas of the United States show that *Wellergyi chesterensis* n. sp. resembles *Wellergyi brazeriana* (Girty) from the Brazer Limestone of northeastern Idaho; *Euconospira* sp. indet. 2 is somewhat similar to *E. disjuncta* Girty, originally described from the Batesville Sandstone of northern Arkansas. *Platyceras* (*Platyceras*) *subrotundum* Snider identified here may also occur in the Pitkin Limestone of

Oklahoma, and, finally, some specimens cannot be distinguished from *Naticopsis* (*Naticopsis*) *suturicompta* Yochelson and Dutro from northeastern Alaska.

Comparisons with Pennsylvanian forms show that *Palaeostylus* (*Stephanozyga*) sp. indet. 1. resembles (*P.*) *S. subnodosa* Knight; *Lepetopsis* sp. indet. resembles *L. parrishi* Gurley; *Donaldina americana* n. sp. is similar to *D. stevensana* (Meek and Worthen); *Donaldina zadoe* n. sp. is close to *D. robusta* (Stevens); and *Baylea okawensis* n. sp. is much like *B. inclinata* (J.M. Weller). Some specimens seem identical with *Ianthinopsis paludinaeformis* (Hall).

Some of the Chester species may be the precursors of Pennsylvanian forms. Thus, *Knightites* (*Cymatospira*) *welleri*, n. sp., with swellings which do not appear at an early growth stage and do not continue laterally as raised ridges into the umbilical regions, and only a moderately flared aperture, may be ancestral to *K.* (*C.*) *montfortianum* (Norwood and Pratten) which has strong undulating folds and a much flared aperture. *Trepospira* (*Trepospira*) *chesterensis* n. sp., without conspicuous subsutural nodes, seems to foreshadow Pennsylvanian species with well-developed rounded nodes. The Chester species also resembles *T.* (*T.*) *rotalia* (Hall) of the Devonian in the absence of conspicuous nodes.

An important factor of the evolution of the Paleozoic gastropods in the superfamily Loxonematacea has been the discovery of *Palaeozygopleura* Horný in the Chester Series. The family Palaeozygopleuridae, to which this genus belongs, has not been reported previously from the United States. Knight (1930), in his elaborate treatment of this family, postulated that the Pennsylvanian pseudozygopleurid genera evolved explosively from *Loxonema*, which originated in the Middle Ordovician through an unknown *Pseudozyglopleura*-like form (Knight, 1930, p. 10, fig. 2), that probably existed in the Devonian or Mississippian. This idea of evolutionary origin was proposed because the rather strongly sigmoidal collabral ornaments of *Loxonema* were thought to be ancestral characters reflected on the earlier whorls of the Pseudozygopleuridae. The unknown form or forms through which Pseudozygopleuridae arose from *Loxonema* are represented most probably by *Palaeozygopleura*. The collabral ornaments of the Palaeozygopleuridae provide what seems to be an evolutionary linkage between *Loxonema* and Pseudozygopleuridae. They are stronger and less sinuous in the Palaeozygopleuridae than in *Loxonema* and extend only as faint growth

lines on the base. They differ from those of the Pseudozygopleuridae by having a more or less uniform sinuosity throughout the whole ontogeny. This sinuosity is greater on the earlier whorls of the Pseudozygopleuridae than on the succeeding whorls, and the ornaments tend to disappear on some of the latter whorls in certain genera, and on the base in all. Thus, the ancestral character seems to be reflected more faithfully in the early than in the late ontogeny of the Pseudozygopleuridae. Therefore, it is most probable that the Palaeozygopleuridae evolved from *Loxonema* directly during the Devonian or Mississippian and gave rise to the Pseudozygopleuridae that flourished in the Pennsylvanian and Permian.

SYNOPTIC CLASSIFICATION OF CHESTER FAUNA FROM THE ILLINOIS BASIN

Sample size

Order Archaeogastropoda Thiele, 1925
Suborder Bellerophontina Ulrich and Scofield, 1897
Superfamily Bellerophontacea M'Coy, 1851
Family Euphemitidae Knight, 1956
Euphemites randolphensis (S. Weller, 1920)..... 36
Family Bellerophontidae M'Coy, 1851
Subfamily Bellerophontinae M'Coy, 1851
Bellerophon (*Bellerophon*) *chesterensis* S. Weller, 1920..... 21
Bellerophon (*Bellerophon*) *claxtonensis* n. sp..... 13
Bellerophon (*Bellerophon*) *menardensis* n. sp..... 4
Subfamily Knightitinae Knight, 1956
Knightites (*Retispira*) *ornatus* (S. Weller, 1920).. 14
Knightites (*Cymatospira*) *welleri* n. sp..... 24
Patellilabia chesterensis n. sp..... 4
Suborder Macluritina Cox and Knight, 1960
Superfamily Euomphalacea deKoninck, 1881
Family Euomphalidae deKoninck, 1881
Straparollus (*Euomphalus*) *planidorsatus* (Meek and Worthen, 1860)..... 19
Straparollus (*Euomphalus*) *illinoisensis* n. sp..... 5
Straparollus (*Euomphalus*) sp. indet. 1..... 9
Straparollus (*Euomphalus*) sp. indet. 2..... 3
Straparollus (*Euomphalus*) sp. indet. 3..... 1
Straparollus (*Euomphalus*) sp. indet. 4..... 1
Straparollus (*Euomphalus*) sp. indet. 5..... 1
Straparollus (*Straparollus*) sp. indet..... 1
Suborder Pleurotomariina Cox and Knight, 1960
Superfamily Pleurotomariacea Swainson, 1840
Family Raphistomatidae Koken, 1896
Subfamily Liospirinae Knight, 1956
Trepospira (*Trepospira*) *chesterensis* n. sp..... 4

Trepospira (*Angyomphalus*) *kentuckiensis* n. sp... 1
Subfamily Omospirinae Wenz, 1938
Baylea okawensis n. sp..... 1
Family Eotomariidae Wenz, 1938
Subfamily Eotomariinae Wenz, 1938
Tribe Ptychomphalides Wenz, 1938
Mourlonia angulata Easton, 1943..... 1
Mourlonia sp. indet..... 3
Euconospira sturgeoni n. sp..... 9
Euconospira cf. *E. sturgeoni* n. sp..... 1
Euconospira sp. indet. 1..... 1
Euconospira sp. indet. 2..... 1
Euconospira sp. indet. 3..... 1
Subfamily Neilsoniinae Knight, 1956
Neilsonia welleri n. sp.....14
Wellergyi chesterensis n. sp.....15
Family Lophospiridae Wenz, 1938
Subfamily Ruedemanniinae Knight, 1956
Yochelsonospira pagoda n. sp. 1
Family Gosseletinidae Wenz, 1938
Subfamily Gosseletininae Wenz, 1938
Gosseletina johnsoni n. sp.....23
Family Porcelliidae Broili, 1924
Porcellia chesterensis n. sp.....13
Family Phymatopleuridae Batten, 1956
Glyptotomaria (*Dictyotomaria*) *yochelsoni*
n. sp..... 3
Borestus chesterensis (Meek and Worthen, 1861).. 7
Borestus cf. *B. chesterensis* (Meek and
Worthen, 1861)..... 2
Phymatopleura nyi n. sp..... 3
Phymatopleura sp. indet..... 2
Superfamily Trochonematacea Zittel, 1895
Family Trochonematidae Zittel, 1895
Kinkaidia cancellata n. sp..... 2
Suborder Patellina von Ihering, 1876
Superfamily Patellacea Rafinesque, 1818
Family Metoptomatidae Wenz, 1938
Lepetopsis chesterensis Worthen, 1884..... 2
Lepetopsis sp. indet..... 1

Suborder Trochina Cox and Knight, 1960
Superfamily Platyceratacea Hall, 1859
Family Platyceratidae Hall, 1859
Platyceras (*Platyceras*) *subrotundum* Snider, 1915. 6
Platyceras (*Platyceras*) sp. indet. 1. 1
Platyceras (*Platyceras*) sp. indet. 2. 1
Platyceras (*Orthonychia*) *chesterense* Meek and Worthen, 1867. 94
Platyceras (*Orthonychia*) *chesterense* variant 1. . . . 48
Platyceras (*Orthonychia*) *chesterense* variant 2. . . . 16
Platyceras (*Orthonychia*) *chesterense* variant 3. . . . 25
Platyceras (*Orthonychia*) *chesterense* variant 4. . . . 5
Strophostylus wortheni (S. Weller, 1916). 11
Strophostylus chesterensis n. sp. 2
Suborder Neritopsina Cox and Knight, 1960
Superfamily Neritacea Rafinesque, 1815
Family Neritopsidae Gray, 1847
Subfamily Naticopsinae S. A. Miller, 1889
Naticopsis (*Naticopsis*) *mariona* n.sp. 12
Naticopsis (*Naticopsis*) *suturicompta* Yochelson and Dutro, 1960. 5
Naticopsis (*Naticopsis*) *waterlooensis* S. Weller, 1916. 52
Naticopsis (*Naticopsis*) sp. indet. 4
Order ?Archaeogastropoda Thiele, 1925
Suborder Murchisoniina Cox and Knight, 1960
Superfamily Murchisoniacea Koken, 1896
Family Murchisonidae Koken, 1896
Aclisina golconda n. sp. 3
Aclisina marvinwelleri n. sp. 5
Stegocoelia (*Stegocoelia*) *kentuckiensis* n. sp. 7
Stegocoelia (*Stegocoelia*) *okawensis* n. sp. 13
Stegocoelia (*Hypergonia*) *baldwinensis* n. sp. 13
Family Plethospiridae Wenz, 1938
Subfamily Pithodeinae Wenz, 1938
Platyzona americana n. sp. 22
Platyzona sp. indet. 1. 1
Platyzona sp. indet. 2. 2
Suborder uncertain
Superfamily Pseudophoracea S. A. Miller, 1889
Family Pseudophoridae S. A. Miller, 1889

Eotrochus marigoldensis n. sp. 15
Order Caenogastropoda Cox, 1959
Superfamily Loxonematacea Koken, 1889
Family Palaeozygopleuridae Horný, 1955
Palaeozygopleura venusta n. sp. 6
Palaeozygopleura welleri n. sp. 12
Palaeozygopleura cf. *P. yandellana* (Hall, 1857) . . 2
Palaeozygopleura wortheni (S. Weller, 1916) 5
Family Pseudozygopleuridae Knight, 1930
Palaeostylus (*Stephanozyga*) sp. indet. 1 5
Palaeostylus (*Stephanozyga*) sp. indet. 2 1
Superfamily Subulitacea Lindström, 1884
Family Subulitidae Lindström, 1884
Subfamily Subulitinae Lindström, 1884
Bulimorpha minor n. sp. 5
Leptoptygma golconda n. sp. 2
Globozyga tenuistriata n. sp. 2
Subfamily Soleniscinae Wenz, 1938
Ianthinopsis littonana (Hall, 1857) 6
Ianthinopsis cf. *I. paludinaeformis* (Hall, 1858) . . 4
Soleniscus sp. indet. 2
Family Meekospiridae Knight, 1956
Meekospira bambooformis n. sp. 18
Meekospira batteni n. sp. 15
Meekospira evansvillensis n. sp. 69
Meekospira minuta S. Weller, 1916 1
Meekospira mississippiensis n. sp. 15
Girtyspira canaliculata (Hall, 1857) 1
Subclass Opisthobranchia Milne Edwards, 1848
Order uncertain
Superfamily Pyramidellacea d'Orbigny, 1840
Family Streptacididae Knight, 1931
Donaldina marigoldensis n. sp. 17
Donaldina americana n. sp. 10
Donaldina zadoe n. sp. 2

PART II

SYSTEMATIC DESCRIPTIONS

Class Gastropoda Cuvier, 1797
Subclass Prosobranchia Milne Edwards, 1848
Order Archaeogastropoda Thiele, 1925
Suborder Bellerophontina Ulrich and Scofield, 1897
Superfamily Bellerophontacea M'Coy, 1851

Discussion.—Bellerophontacea shares similarity with Pleurotomariacea by having an anal emargination which occurs close to the middle of the labrum. The only obvious dissimilarity between the two superfamilies is in the manner of coiling; whereby bellerophontid gastropods coiled isotropically, the other coiled conospirally. The living pleurotomarians retain vestiges of primitive symmetry, for both members of bilaterally paired internal organs, such as ctenidia, are in general developed, although not equally. In this respect pleurotomarians show relationship with the supposedly symmetrically arranged soft anatomy of bellerophonts, a view supported by the bilaterally symmetrical shell. Thus it is assumed that torsion also took place in the bellerophonts as it does in the Pleurotomariacea, and the degree of a symmetry lacking in the bellerophont shells is only due to the early stage in phylogeny and the vestigial symmetry was probably still expressed more fully in them (Knight, 1952).

Stratigraphic range.—Lower Cambrian to Lower Triassic.

Family Euphemitidae Knight, 1956

Discussion.—Horný (1963) accepted the classificatory system as published in the *Treatise on Invertebrate Paleontology* with some exceptions. Mainly he excluded the subfamily Euphemitinae from the family Sinuitidae. He did not consider this group to be related to sinuitid bellerophontids, but as an independent, highly specialized family. Batten (1966) agreed with Horný's conclusion.

Genus **Euphemites** Warthin, 1930

Euphemites.[1] Warthin, 1930, Bull. Okla. Geol. Surv., **53**, p. 44; King, 1940, Jour. Paleontol., **14**, p. 150; Knight, 1941, Geol. Soc. Amer. Sp. Papers, 32, pp. 122–123; Moore, 1941, Bull. State Geol. Surv. Kan., **38**, p. 129; Knight et al., 1960, Treat. Invert. Paleontol. Part I, p. 178; Yochelson, 1969, Bull. Amer. Mus. Nat. Hist., **119**, pp. 231–235.

Type species.—*Bellerophon urii* Fleming, 1828.

Definition.[2]—Numerous more or less strong sharp spiral cords on parietal inductura, reaching far within whorls and commonly continuing with inductura over exterior rather more than a half volution; similar but usually slightly stronger cords on coinductura where this layer is present; anterior half (perinductura) usually smooth although with pustules in some species.

Stratigraphic range.—Mississippian to Permian.

American Mississippian species.—The following species have been described from Mississippian formations of North America:

Euphemites compressus Elias, 1958 (pp. 1–2, pl. 1, figs. 3–4), Redoak Hollow Formation, Oklahoma.

Euphemites incarinatus Easton, 1943 (p. 150, pl. 24, fig. 22), Pitkin Formation, Arkansas.

Euphemus lentiformis S. Weller, 1916 (p. 258, pl. 19, figs. 9–10), Ste. Genevieve Limestone, Illinois.

Euphemus randolphensis S. Weller, 1920b (pp. 365–366, pl. 9, figs. 7–10), Chester Series, Basal Okaw, and Basal Golconda Limestones, Illinois.

Euphemites sacajawensis C.C. Branson, 1937 (pp. 658–659, pl. 89, figs. 24–25, 33), Sacajawea Formation, Wyoming.

Bellerophon stamineus Conrad, 1842 (pp. 269–270, pl. 15, fig. 13), Carboniferous Formation, Michigan.

Euphemus ? sp. undetermined. S. Weller, 1899 (p. 40, pl. 5, figs. 10–11), Northview Sandstone, Missouri; Beede, 1911 (p. 184, text-figs.), Mississippian, Quebec; Girty, 1915 (p. 120), Batesville Sandstone, Arkansas.

Discussion: Structure and mode of formation of shell layers in *Euphemites* is very interesting. J.M. Weller (1930) has shown that the revolving lirae are the characteristic features of the genus and

[1] Only references to the American Mississippian synonymy are given for this and the following genera.

[2] This and the following definitions are greatly influenced by Knight et al (1960) diagnoses.

are formed on the inductura layer, rather than on the true outer shell layers. In his study of *Euphemites callosus* J.M. Weller (1930) recognized six layers, three inner and three outer ones. The inner layers generally have laminations, or sometimes lenticular structures which are sloping away from the aperture. Layer 1 is the innermost layer and it is not easily distinguishable from layer 2 which lies outside of it. Layer 3 is the thickest and darkest layer. These three layers are the true shell layers which are formed internally by the mantles.

The three outer layers 4, 5, and 6 have different sets of laminations sloping adapertually, and revealing the external mode of formation by the mantles. Layer 4 is responsible for the smooth area always present at the anterior portion of the shell. The nature of laminations in this adapertually sloping layer, and its position that starts from the anterior portion of the aperture, obviously indicate that: (1) this layer was formed by the anterior and anterolateral extension of the mantle which was reflected backwards to cover the lateral and dorsal surfaces of the shell; and (2) was formed at the same time as shell layer 3.

Layer 5 is the thinnest. It also has laminations sloping adapertually (Moore, 1941, p. 134, figs. 1A–D). This layer is responsible for the presence of revolving lirae which extend from the aperture to cover some part of the shell beyond it. Layer 5 is unmistakably deposited by the posterior extension of the mantle flap which folds backwards and covers the body of the shell. The revolving lirae are printed on this layer by the grooves of the mantle flap.

Finally, layer 6, which is the outermost and the thickest layer in some species, has the same type of laminations as layer 5, but the two sets are usually unconformable. Layer 6, which extends only for a short distance beyond the aperture, is deposited by the inner extension of the posterior mantle flap. Like layer 5, this layer folds backwards and covers the body of the shell.

Moore (1941) also discussed this subject and proposed two additional terms, besides inductura, for the three external layers of *Euphemites*. The term inductura, which means "a covering" in Latin, was coined by Knight (1931a, p. 180) for the shell layer of gastropods that is nearly always found covering the region of the inner lip of the aperture. Moore designated layer 6 as co-inductura and layer 4 as perinductura. Layer 5, of course, is the inductura layer.

Moore's line of reasoning for formation of the inductura layers is somewhat similar to that of Weller's. In contrast, Yochelson (1960, pp. 232, 233) suggested that co-inductura and inductura layers are not deposited by two separate posterior mantle extensions, but are formed by a single posterior extension of the mantle flap. An inductura layer was formed when the mantle flap was in a well-extended position, and the co-inductura layer was formed when it was retracted. The greater thickness of the co-inductura, according to Knight (*in* Yochelson, 1960, p. 232), is either due to the rapid secretion of the mantle flap in this position, or longer duration of the mantle in this position. This assumption of the deposition of two different inductura layers made by a single posterior mantle extension is also interesting.

The existence of co-inductura can be judged externally by the presence of geniculation or a thickened layer just behind the aperture so that the surface of the whorl is not perfectly circular or rounded in the lateral profile. Species such as *E. callosus* (J.M. Weller, 1930), *E. graffhami* Moore, 1941, *E nodocarinatus* (Hall, 1858), *E. inspeciosus* (White, 1881), and *E. imperator* Yochelson, 1960, have such geniculation. In addition to geniculation, there usually is a smooth area between the two sets of lirae of the inductura and co-inductura layers, and there is also likely to be a discordance between the two sets of lirae, or, if they are concordant, the intensity and strength of the two sets of lirae may not be the same (e.g., *E. regulatus* Moore, 1941, p. 145, pl. 1, figs. 6a–b).

E. graffhami Moore, 1941 (pp. 142–145, pl. 2, figs. 1a–c, 4b) superficially shows no evidence of the presence of an inductura layer. Only the thickened co-inductura layer bearing lirae extends for a short distance beyond the aperture, whereas the rest of the volution is smooth. More assumed that this indicates the absence of an inductura layer. However, there is a strong possibility that the inductura layer actually is present, but fails to have lirate impressions on it because the mantle flap that is responsible for the inductura must have stretched out extensively over the distinctly globose surface of such a shell, or simply because of poor preservation. The smoothness of the inductura layer on most of the nodal swellings of *E. randolphensis* might also be explained in this way.

A majority of the species of *Euphemites* seem to have no evidence of the presence of co-inductura, especially when they are studied externally only. Such shells have no geniculation and the shell profile is smoothly curved. However, it is interesting that Moore (1941,

p. 134, fig. 3b) pointed out that because this species is without geniculation, there is an undifferentiated layer composed of both layers 5 and 6 in the longitudinal section of *E. vittatus* (McChesney). Thus, for the supposedly smoothly curved shells of *Euphemites* it is essential and very important to cut sections to find out the true nature of the layers. The species lacking geniculation, or having smoothly curved profiles, and thus possibly lacking co-inductura are: *E. aequisulcatus* Chronic, 1952; *E. batteni* Yochelson, 1960; *E. blanyanus* (McChesney, 1859); *E. compressus* Elias, 1958; *E. crenulatus* Yochelson, 1960; *E. exquisitus* Yochelson, 1960; *E. incarinatus* Easton, 1943; *E. kingi* Yochelson, 1960; *E. lentiformis* (S. Weller, 1916); *E. luxuriosus* Yochelson, 1960; *E. randolphensis* (S. Weller, 1920); *E. regularis* Moore, 1941; *E. sacajawensis* Branson, 1937; *E. sparciliratus* Yochelson, 1960; *E. stamineus* (Conrad, 1842); *E. vittatus* (McChesney, 1859).

In the study of *E. randolphensis*, longitudinal sections were cut to determine the shell structure, but, unfortunately, recrystallization was so complete that the structure is totally destroyed. Nevertheless, some specimens show traces of shell structure externally, especially when smooth layer 4 is broken away. In these specimens, it is clear that lunules of the selenizone are made by the internal shell layer 3 whose color is darker than the color of layer 4. Dark bands of shell layer 3 are also seen at either side of the selenizone in the form of growth lines lying parallel to the margin of the aperture. Traces of light material, undoubtedly of layer 4, are seen in some low-lying grooves between the dark color bands. Nodal swellings usually have the same texture as that of layer 4 or 5, and they most probably are formed by the local thickening of layer 3 and subsequently were covered by layers 4 and 5. In some specimens—but not all—these nodal swellings, although present on the lirate inductura portion of the shell, are smooth and without any revolving lirae. This might be because the mantle flap which was responsible for the deposition of the inductura layer had to stretch out more on these swellings than on the adjoining areas and the grooves of the mantle flap might have been too weak to print the lirate impressions. The presence of layer 6 is not obvious, as there is neither geniculation nor discordance in the trend of the revolving lirae.

Euphemites randolphensis (S. Weller, 1920). Figure 10.

Euphemus randolphensis. S. Weller, 1920, Bull. Ill. Geol. Surv., no. 41, pp. 365–366, pl. 9, figs. 7–10.

TABLE 2.—Measurements (in mm.) of *Euphemites randolphensis* (S. Weller, 1920).

Specimen FMNH UC	L	W	Wb	H	Wa	La	Ws	Ns
25418	9.4	8.7	4.0	7.9	7.4	2.8	2.0±	23
25416-1	10.0	9.0	4.0	8.5	7.5	3.0	2.0±	21
25416-2	10.0	9.0	4.3	8.3	...	...	1.8	29
25416-3	7.6	5.6	2.8	6.2	4.4	2.0	1.6	30
25090-1	10.9	8.0	5.0	9.6	...	...	2.0±	36
25090-2	10.9	...	4.4	8.8	...	...	2.1	29
25090-3	10.0	8.9	4.5	8.4	7.2	...	...	..
25090-4	7.6	6.0	3.1	6.8	...	...	...	19
25090-5	8.2	7.6	3.9	7.0	...	...	1.9	21
25090-6	5.0	4.4	1.9	4.5	...	...	...	19
25320-1	14.4	14.0	...	12.2	...	...	...	..
25320-2	12.9	12.5	7.0	11.1	10.8	3.9	2.9±	27
25320-3	11.2	9.6	4.6	9.3	7.9	3.8	2.4	33
31691-1	8.9	7.3	4.0	7.5	...	...	...	23
31691-2	9.9	8.1	4.1	8.0	6.8	3.0	1.9	25
31691-3	8.6	6.8+	...	7.3	...	...	...	23
31691-4	9.0	6.8	3.4	7.6	...	...	...	19
31691-5	8.7	7.0	3.4	7.2	...	...	...	20
31691-6	7.4	6.0	3.4	6.7	...	...	...	..
31691 7	7.2	5.7	2.7	6.3	...	...	...	..
31691-8	6.9	5.4	2.5	6.0	...	...	...	26
26955-1	11.3	9.2	4.7	9.0	...	...	...	28
30470a-1	11.0	9.0	5.1	8.9	8.5	3.9	...	23
N	23	22	...	23	...	...	...	..
Total	217.0	175.5	...	183.1	...	...	...	..
Mean	9.43	7.98	...	7.96	...	...	...	..
S.D.	2.13	2.35	...	2.2	...	...	...	..
S.E.(m)	0.69	0.77	...	0.47	...	...	...	..

Corr. Coeff. between L and W = +0.95
Corr. coeff. between L and H = +0.986

Description.—Length and width nearly equal, nonumbilicate. Enlargement regular, last whorl approximately twice the width of its predecessor. Whorl profile evenly rounded in young specimens, somewhat distorted toward aperture in larger shells by intermittent, very low broad swellings almost half way between selenizone and umbilical region. These are somewhat variably prominent and first appear at different growth stages in different specimens. Depth of slit not known, probably very shallow.

Selenizone wide, up to one-fourth or more as wide as whorl. Outer lip unknown in all specimens, probably thin, thickening laterally into umbilicus but not recurved. Somewhat more than the last half of the final whorl nearly smooth, growth lines generally obscure except where they turn back near the selenizone which they meet at an angle of about 45 degrees. Selenizone marked by equally obscure semicircular growth lines. Remainder of last whorl covered by a thin deposit laid down by the recurved portion of mantle. This bears

FIG. 10. *Euphemites randolphensis* (S. Weller, 1920). **(a)** posterior view, × 4 (25090-3); **(b)** dorsal view, × 4, same specimen; **(c)** apertural view, × 4, same specimen; **(d)** left lateral view, × 4, same specimen; **(e)** right lateral view, × 4 (25090–1); **(f)** apertural view, × 4, same specimen; **(g)** posterior view, × 4 (31691–1); **(h)** left lateral view, × 4, same specimen; **(i)** posterior dorsal view, × 4 (25320–1).

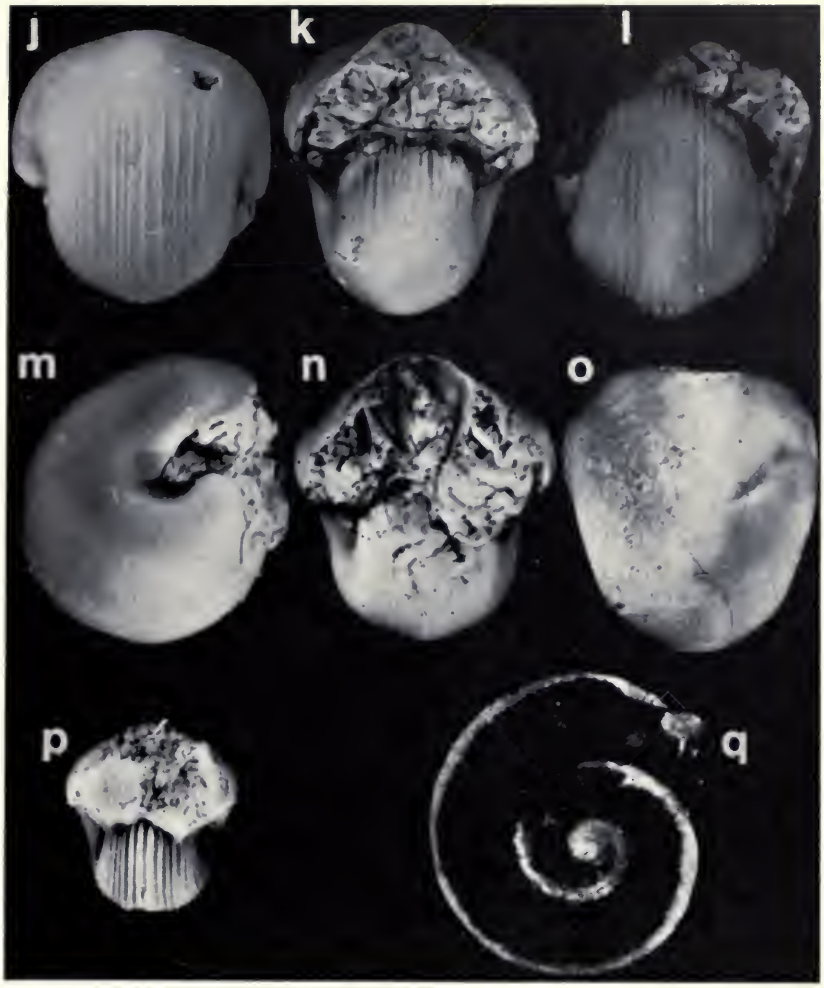

FIG. 10. *Continued.—Euphemites randolphensis* (S. Weller, 1920). **(j)** dorsal view, × 4, same specimen; **(k)** apertural view, × 4 (31691–2); **(l)** apertural view, × 4.5 (25090–5); **(m)** right lateral view, × 4 (25090–4); **(n)** apertural view, × 4, same specimen; **(o)** posterior view, × 4, same specimen; **(p)** apertural view of an immature specimen, × 5 (25090–6); **(q)** section, × 5 (25090-F). All FMNH UC.

coarse rounded lirae generally separated by wider concave interspaces. Spacing of lirae somewhat even, varying considerably on different specimens, being closer on some where they overlie the selenizone than on the sides.

Liral number generally increasing as shells enlarge by additions near the umbilical regions, but a few appear by implantation between old ones. Most lirae continuous except in the initial parts of new lateral additions where irregularities and interruptions occur. Lirae continue into shell aperture but the deposit is not notably thickened there.

Comparisons.—*Euphemites randolphensis* differs from *E. carbonarius* (Cox), a common Pennsylvanian species in having less globular form, weaker lirae, more prominent dorsal selenizonal ridge, and nodal swellings. It differs from *E. sacajawensis* Branson, 1937 (pp. 658–659, pl. 89, figs. 24, 25, 33), a Mississippian form from Wyoming, by being less rounded in form. The lateral compression also resembles *E. compressus* Elias, 1958, (pp. 1–2, pl. 1, figs. 3, 4), an Upper Mississippian form with nodal swellings.

Measurements.—Measurements and ratios of measurements are given in Tables 2 and 3.

TABLE 3.—Ratios of *Euphemites randolphensis* (S. Weller, 1920).

Specimen FMNH UC	L/W	L/H	W/Wb
25418	1.08	1.19	2.18
25416-1	1.11	1.17	2.25
25416-2	1.11	1.20	2.09
25416-3	1.36	1.23	2.00
25090-1	1.36	1.13	1.60
25090-2	....	1.23	....
25090-3	1.12	1.17	1.98
25090-4	1.27	1.12	1.94
25090-5	1.08	1.17	1.95
25090-6	1.14	1.11	2.32
25320-1	1.03	1.18	....
25320-2	1.03	....	1.78
25320-3	1.16	1.20	2.09
31691-1	1.22	1.19	1.83
31691-2	1.22	1.21	1.98
31691-3	1.26	1.18	....
31691-4	1.32	1.20	2.00
31691-5	1.24	1.21	2.06
31691-6	1.23	1.11	1.76
31691-7	1.26	1.14	2.11
31691-8	1.28	1.15	2.16
26955-1	1.22	1.25	1.96
30470a-1	1.11	1.23	1.94
N	22	22	20
Total	26.21	25.97	39.95
Mean	1.19	1.18	2.00

Material, stratigraphic positions, and localities.—Thirty-six specimens including holotype and other figured specimens from five localities. Holotype: by original designation, FMNH UC 25418, S. Weller, 1920, pl. 9, fig. 7, Basal Okaw Limestone, Locality 2; three specimens FMNH UC 25416, S. Weller, 1920, pl. 9, fig. 8 (25416-A), figs. 9, 10 (25416-B), Lower Golconda Limestone, Locality 13; three specimens FMNH UC 25320, Lower Okaw Limestone, Locality 2; seven specimens FMNH UC 25090, Lower Okaw Limestone, Locality 11; nine specimens FMNH UC 31691, Lower Golconda Limestone, Locality 13; 12 specimens FMNH UC 30470, Golconda Limestone, Locality 9; one specimen FMNH UC 26955, Renault Limestone, Locality 10.

Family Bellerophontidae M'Coy, 1851
Subfamily Bellerophontinae M'Coy, 1851

Genus **Bellerophon** Montfort, 1808

Diagnosis.—Whorls commonly broadly rounded but some may have subdued crest (Knight et al., 1960, p. 182).

Discussion.—Three subgenera are currently recognized:

Bellerophon (*Bellerophon*) Montfort, 1808
Bellerophon (*Aglaoglypta*) Knight, 1942
Bellerophon (*Pharkidonotus*) Girty, 1912

Subgenus **Bellerophon** Montfort, 1808

Type species.—*Bellerophon vasulites*, Montfort, 1808.

Definition.—Bellerophontid gastropods with a smooth inductura; slit narrow, depth variable among species; selenizone distinct, commonly on a dorsal crest; narrowly phaneromphalous or anomphalous; lips flaring slightly near umbilici; inductura thin to thickened slightly but smooth, extending only a short distance out of the plane of aperture; ornament predominantly collabral.

Stratigraphic Range.—Silurian to Lower Triassic.

American Mississippian species.—Numerous species have been referred to *Bellerophon* in the past, but because of the dividing of the genus into several subgenera, and the establishing of other related new genera in recent years, very few species are left in *Bellerophon*. Many of the species of *Bellerophon* which have been reported in the

literature are either unfigured or poorly figured, and thus can hardly be recognized. The following species which are figured from the Mississippian formations of the United States are recognized:

Bellerophon bilabiatus White and Whitfield, 1862 (see Keyes, 1894, p. 147, pl. 50, fig. 3), Kinderhook Group, Iowa.

Bellerophon blairi Miller and Gurley, 1896 (p. 21, pl. 3, figs. 7, 8), Chouteau Limestone, Missouri.

Bellerophon chesterensis S. Weller, 1920a (p. 365, pl. 9, figs. 1–6), Chester Series, Illinois.

Bellerophon gibsoni White, 1882 (pp. 360–361, p. 41, figs. 4–6), St. Louis Group, Indiana.

Bellerophon jeffersonensis S. Weller, 1906 (pp. 457–458, pl. 7, fig. 24), Kinderhook Group, Missouri.

Bellerophon majusculus Walcott, 1884 (pp. 256–257, pl. 23, figs. 1, 1a; pl. 24, fig. 6, text-fig. 3), Lower Carboniferous, Nevada.

Bellerophon mansfieldianus Girty, 1927 (pp. 413–414, pl. 22, fig. 40), Madison Limestone, Idaho.

Bellerophon pitkinensis Snider, 1915 (p. 115, pl. 7, figs. 6–7), Pitkin Formation, Oklahoma.

Bellerophon sublaevis Hall, 1856 (see Hall and Whitney, 1858, p. 666, pl. 23, figs. 15a–c), Salem Limestone, Indiana.

Bellerophon ulrichi S.Weller, 1906 (pp. 456–457, pl. 2, figs. 20–23), Kinderhook Group, Missouri.

Bellerophon vinculatus White and Whitfield, 1862 (see S. Weller, 1900, p. 113, pl. 6, figs. 11, 12), Kinderhook, Missouri.

Bellerophon (Bellerophon) chesterensis S. Weller, 1920. Figure 11.

Bellerophon chesterensis. S. Weller, 1920a, Bull. Ill. Geol. Surv., no. 41, p. 365, pl. 9, figs. 1–6; J. M. Weller, 1931, Ky. Geol. Surv., ser. 6, **36**, pl. 42, figs. 3a–b.

Description.—Length equal to width; umbilicus closed with thickened shell. Enlargement regular, last whorl nearly twice the width of its predecessor. Whorl profile evenly rounded in young stages, becoming considerably flattened in center at maturity; aperture more than twice as wide as long. Slit shallow, about 10 per cent of circumference of last whorl. Selenizone about 10 per cent of width, convexly elevated, becoming much more prominent toward aperture of matured specimens. Outer lip thin, much thickened laterally

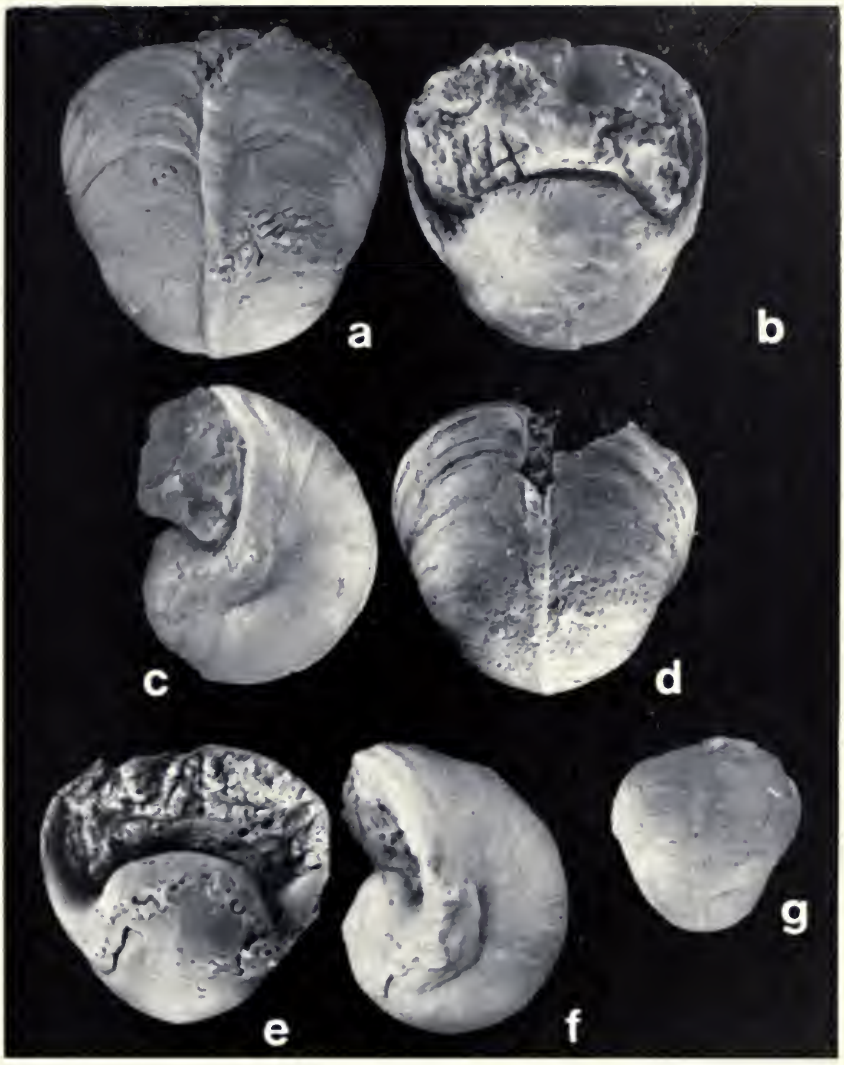

FIG. 11. *Bellerophon* (*Bellerophon*) *chesterensis* S. Weller, 1920. **(a)** anterior view of holotype, × 2 (25322); **(b)** apertural view, × 2, same specimen; **(c)** left lateral view, × 2, same specimen; **(d)** anterior view, × 2 (56278); **(e)** apertural view, × 2, same specimen; **(f)** left lateral view, × 2, same specimen; **(g)** anterior view of an immature specimen, × 2.5 (56279). All FMNH UC.

TABLE 4.—Measurements (in mm.) of *Bellerophon (Bellerophon) chesterensis* S. Weller, 1920.

Specimen FMNH UC	L	W	Wb	H	Wa	La	La′	Ws
56278	11.6	11.2	6.0	8.4	10.2	4.1	5.5	0.7
56279	19.2	19.9	11.6	14.2	16.3	6.8	10.6	1.4
25322	20.5	20.4	12.4	16.0	18.7	8.6	11.4	1.9
25415-1	16.9	16.8	8.5	12.5	....	...	....	...

into the umbilical regions. Parietal inductura of inner lip thin, covering about one-fifth of the last whorl, thickening slightly internally. Growth lines closely spaced, curved sharply into selenizone, delicate in immature region, becoming irregular and more prominent toward aperture of mature specimens. Selenizone marked by somewhat irregular, mostly gently concave grooves.

Comparison.—*B. (Bellerophon) chesterensis* differs from the other Carboniferous species by its flattened surface near the aperture at maturity, and from *B. (B.) sublaevis* in having a flattened upper surface, relatively broader shell, and more conspicuous growth lines.

Measurements.—Measurements and ratios of measurements are given in Tables 4 and 5.

TABLE 5.—Ratios of *Bellerophon (Bellerophon) chesterensis* S. Weller, 1920.

Specimen FMNH UC	L/W	L/H	W/Wb	Wa/La	La′/La
56278	1.04	1.38	1.87	2.49	1.34
56279	0.94	1.35	1.72	2.40	1.56
25322	1.00	1.28	1.65	2.17	1.31
25415-1	1.01	1.35	1.98	....	....

Material, stratigraphic position, and localities.—Four good specimens, including holotype, from two localities, and 17 specimens, mostly steinkerns, from two other localities: Holotype by original designation, FMNH UC 25322 (S. Weller, 1920b, pl. 9, figs. 1–3); one specimen, FMNH UC 56278 (J. M. Weller, 1931, pl. 42, figs. 3a, b); one specimen, FMNH UC 56279, Lower Okaw Limestone, Locality 2; one specimen, FMNH UC 25415 (S. Weller, 1920b, pl. 9, figs. 4–6), three specimens, FMNH UC 31693, Lower Golconda Limestone, Locality 13; three specimens, FMNH UC 26677, Menard Limestone, Locality 6; 11 specimens, FMNH 30336, Glen Dean Limestone, Locality 12.

Bellerophon (Bellerophon) claxtonensis new species. Figure 12.

Description.—Width slightly less than length; nonumbilicate. Enlargement regular, last whorl less than twice the width of its

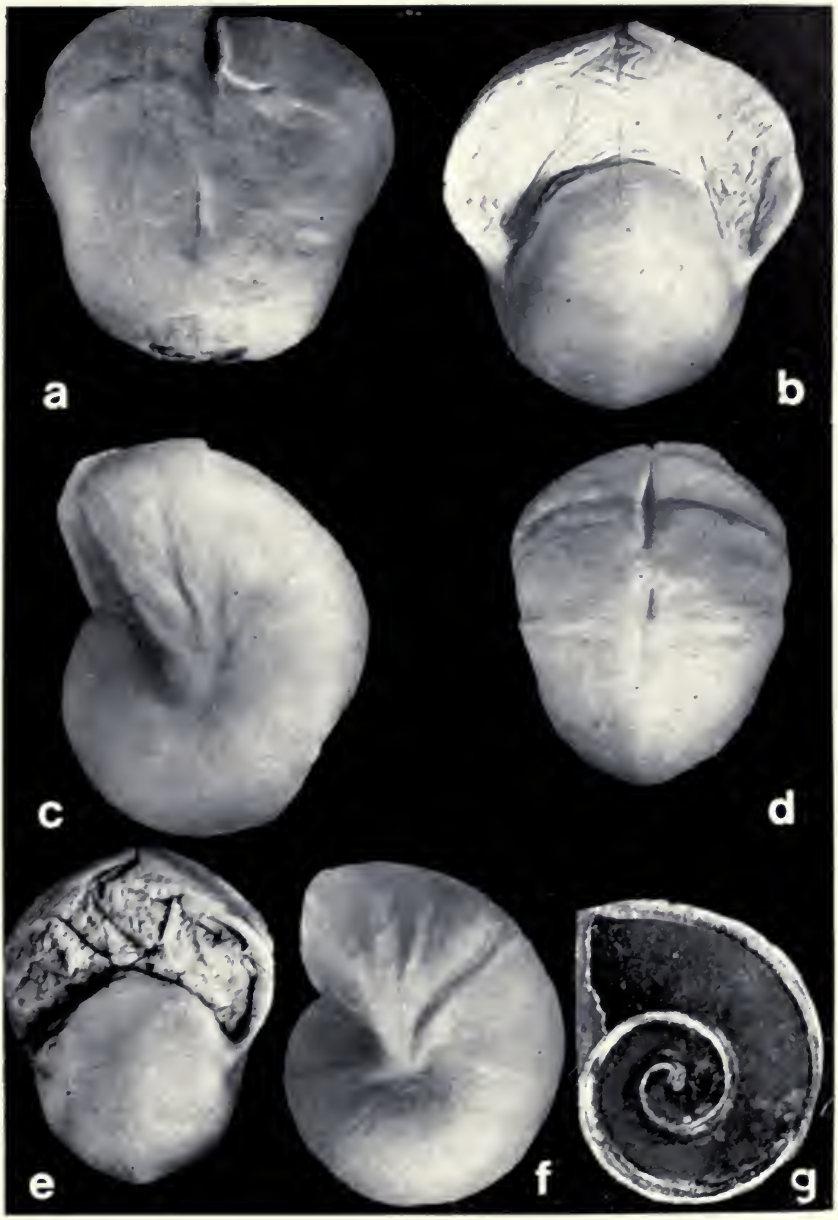

FIG. 12. *Bellerophon (Bellerophon) claxtonensis* n. sp. **(a)** anterior dorsal view, × 2 (30473-9); **(b)** apertural view, × 2, same specimen; **(c)** left lateral view, × 2, same specimen; **(d)** dorsal view of holotype, × 2 (56280); **(e)** apertural view, × 2, same specimen; **(f)** left lateral view, × 2, same specimen; **(g)** section, × 2.5 (30473-A). All FMNH UC.

TABLE 6.—Measurements (in mm.) of *Bellerophon* (*Bellerophon*) *claxtonensis* n. sp.

Specimen FMNH UC	L	W	Wb	H	Wa	La	La′	Ws
30473-1	18.0	15.4+	....	15.2	....	...	....	...
30473-2	16.6	15.7	9.8	13.4	14.3	5.5	9.8	1.0
30473-3	18.5+	19.6	10.2	....	....	...	....	...
30473-4	17.8	17.3	9.9	14.2	14.7	6.0	....	...
30473-5	20.1	18.8	10.5	15.7	16.2	...	....	1.1
30473-6	21.5	18.8	11.0	16.4	15.5	6.9	10.4	...
30473-7	21.8	19.6	11.8	17.3	17.3	6.3	11.0	1.1
56280	23.7	18.2	11.8	18.3	15.9	7.0	13.2	1.1
30473-9	26.3	24.0	13.6	20.0	22.5	7.9	14.5	1.2

predecessor. Whorl profile evenly rounded at maturity. Slit relatively shallow, about 15 per cent of the circumference of the last whorl. Selenizone narrow, convex, slightly elevated, not set off abruptly from slopes on either side. Outer lip thin, moderately thickened laterally into umbilical regions. Parietal inductura of inner lip thin, covering about one-sixth of last whorl, not thickened noticeably internally. Growth lines indistinct except near aperture of largest individual.

Comparisons.—This species differs most conspicuously from *Bellerophon chesterensis* in having a much smoother surface with less distinct growth lines, and less elevated selenizone. Also, the whorl profile is not flattened near the aperture and the umbilical depressions are not so completely filled up by the thickened lateral lips. It differs from *B.* (*B.*) *sublaevis*, from the Salem Limestone (see Hall, 1858, p. 666, pl. 23, figs. 15a–c) by lack of lateral flaring of the aperture, and from *B.* (*B.*) *yuani*, from the Middle Carboniferous of North China (Yin, 1932, pl. 1, figs. 5c, 6c), by lack of sinuses in the lateral apertural margin, where this nears the earlier portion of the shell.

Measurements.—Measurements and ratios of measurements are given in Tables 6 and 7.

TABLE 7.—Ratios of *Bellerophon* (*Bellerophon*) *claxtonensis* n. sp.

Specimen FMNH UC	L/W	L/H	W/Wb	Wa/La	La′/La
30473-1	....	....	....	....	....
30473-2	1.05	1.24	1.60	2.60	1.78
30473-3	....	....	1.92	....	....
30473-4	....	1.25	1.75	2.45	....
30473-5	1.07	1.28	1.79	....	....
30473-6	1.14	1.31	1.71	2.25	1.51
30473-7	1.11	1.26	1.66	2.75	1.75
56280	1.30	1.31	1.54	2.27	1.89
30473-9	1.10	1.32	1.66	2.85	1.84

Material, stratigraphic position, and localities.—Thirteen specimens, three nearly perfect, from two localities. Holotype: FMNH UC 56280, one specimen FMNH UC 56281, eight specimens, FMNH UC 30473, Golconda Limestone, Locality 9; three specimens, FMNH UC 26676, Menard Limestone, Locality 6.

Bellerophon (Bellerophon) menardensis new species. Figure 13.

Description.—Length and width nearly equal, umbilicus closed with thickened shell. Enlargement regular, last whorl about twice the width of its predecessor. Whorl profile evenly rounded. Depth of slit unknown. Selenizone narrow, varying somewhat in width, flush with surface on either side except near aperture where it is slightly elevated, bounded by very shallow grooves. Outer lip thin, much thickened laterally into umbilical region where it is slightly flared. Parietal inductura of inner lip covering about one-fifth of last whorl, outer edge thin but thickening backward from about half of the distance from the aperture. Growth lines closely spaced, very shallow grooves, curving sharply back into selenizone which is crossed by straight transverse grooves.

Comparisons.—This specimen is somewhat intermediate in form between *B.* (*B.*) *chesterensis* and *B.* (*B.*) *claxtonensis*. It differs principally from the former in lack of flattening of the whorl profile near the aperture, more delicate growth lines, and unelevated selenizone. It differs from the latter mainly in the greater thickening of shell and slight flaring of the aperture in the umbilical regions and thickening of the calloused inner lip inward from its margin. It differs from *B.* (*B.*) *sublaevis* in its more globose shape and transverse aperture. It differs from *B.* (*B.*) *crassus* var. *wewokanus* (Girty, 1911, p. 138; 1915b, p. 164, pl. 19, figs. 1–3b) by having a transverse aperture, rounded whorls, and thickened inductura.

TABLE 8.—Measurements (in mm.) of *Bellerophon* (*Bellerophon*) *menardensis* n. sp.

Specimen FMNH UC	L	W	Wb	H	Wa	La	La′	Ws
56282	25.3	24.4	13.6	20.0	16.8	9.0	12.0	1.5

Measurements.—Measurements and ratios of measurements are given in Tables 8 and 9.

TABLE 9.—Ratios of *Bellerophon* (*Bellerophon*) *menardensis* n. sp.

Specimen FMNH UC	L/W	L/H	W/Wb
56282	1.04	1.27	1.79

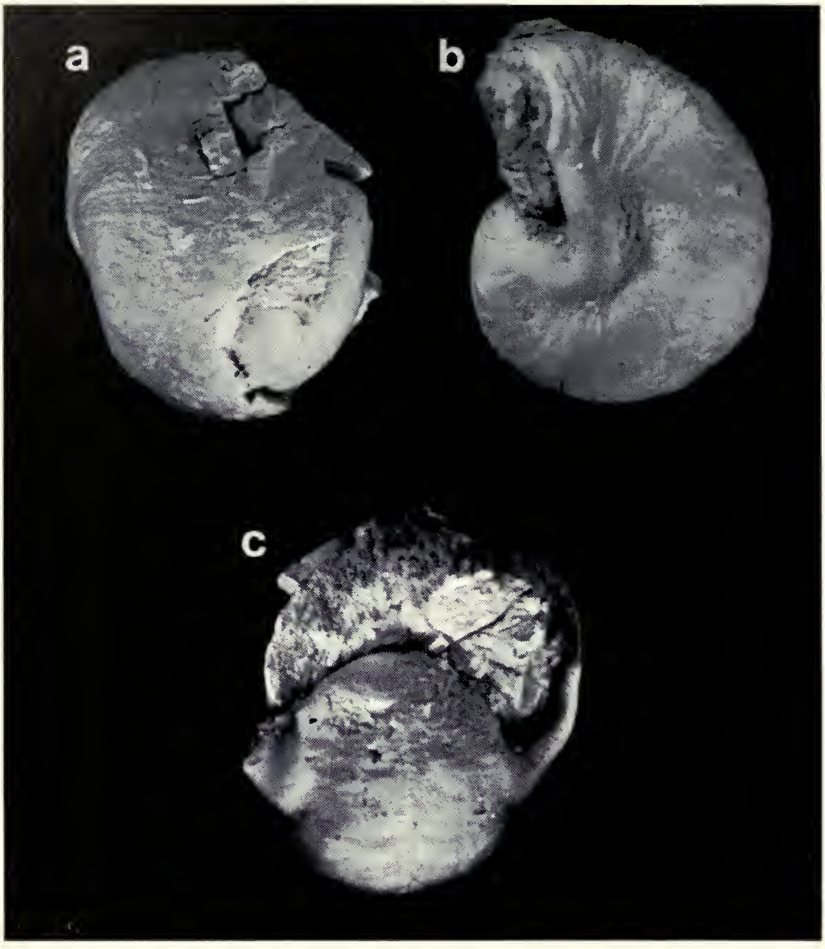

FIG. 13. *Bellerophon (Bellerophon) menardensis* n. sp. **(a)** anterior dorsal view of holotype, × 2 (FMNH UC 56282); **(b)** left lateral view, × 2, same specimen; **(c)** apertural view, × 2, same specimen.

Material, stratigraphic position, and localities.—One somewhat imperfect specimen and three other fragments from a single locality. Holotype: FMNH UC 56282; three specimens FMNH UC 25442, Menard Limestone, Locality 6.

Subfamily Knightitinae Knight, 1956

Genus **Knightites** Moore, 1941

Knightites. Moore, 1941, Bull. State Geol. Surv. Kan. 38, pp. 149–153;

Knight et al., 1960, Treat. Invert. Paleontol., part I, p. 184; Yochelson, 1960, Bull. Amer. Mus. Nat. Hist., **119**, pp. 241–243.

Type species.—*Knightites multicornutus* Moore, 1941.

Definition.—Spiral ornament generally conspicuous, generally crossed by well-developed collabral elements.

Stratigraphic range.—Devonian to Middle Permian.

Subgenus **Retispira** Knight, 1945

Type species.—*Retispira bellireticulata* Knight, 1945.

Definition.— Lateral lips of aperture expanded only moderately or not at all, incurrent channels inconspicuous, parietal inductura commonly thin; collabral ornament ranging from fine growth lines to cords and undulations.

Stratigraphic range.— Devonian through Middle Permian.

American Mississippian species.— The following species which have been figured and reported from the Mississippian formations of of the United States are transferred to *Retispira:*

Bucanopsis deflectus S. Weller, 1900 (pp. 114–115, pl. 6, fig. 5), Kinderhook Group, Iowa.

Bellerophon monronesis S. Weller, 1916 (pp. 257–258, pl. 19, figs. 7, 8), Ste. Genevieve Limestone, Illinois.

Bucanopsis ornatus S. Weller, 1920b (pp. 366–367, pl. 9, figs. 15–20), Chester Series, Illinois.

Bellerophon perelegans White and Whitfield, 1862 (see S. Weller, 1901, *Bucanopsis perelegans*, pp. 178–179, pl. 15, figs. 23–24), Kinderhook Group, Iowa.

Bucanopsis (*Retispira*?) *reticulata* Elias, 1958 (pp. 3–4, pl. 1, figs. 5–7), Late Mississippian, Oklahoma.

Bellerophon sedaliensis Miller and Gurley, 1896 (pp. 21–22, pl. 3, figs. 9, 10), Chouteau Limestone, Missouri.

Bellerophon textilis Hall, 1856 (suppressed synonym of *B. cancellatus* Hall, 1856; see Hall, 1883, pp. 371–372, pl. 31, figs. 4, 5), Salem Limestone, Indiana.

Bucanopsis waverliensis Hyde, 1953 (pp. 321–322, pl. 46, figs. 29–31), Waverly Group, Ohio.

Knightites (Retispira) ornatus (S. Weller, 1920). Figure 14.

Bucanopsis ornatus S. Weller, 1920a, Bull. Ill. Geol. Surv., no. 41, pp. 366–367, pl. 9, figs. 15–20.

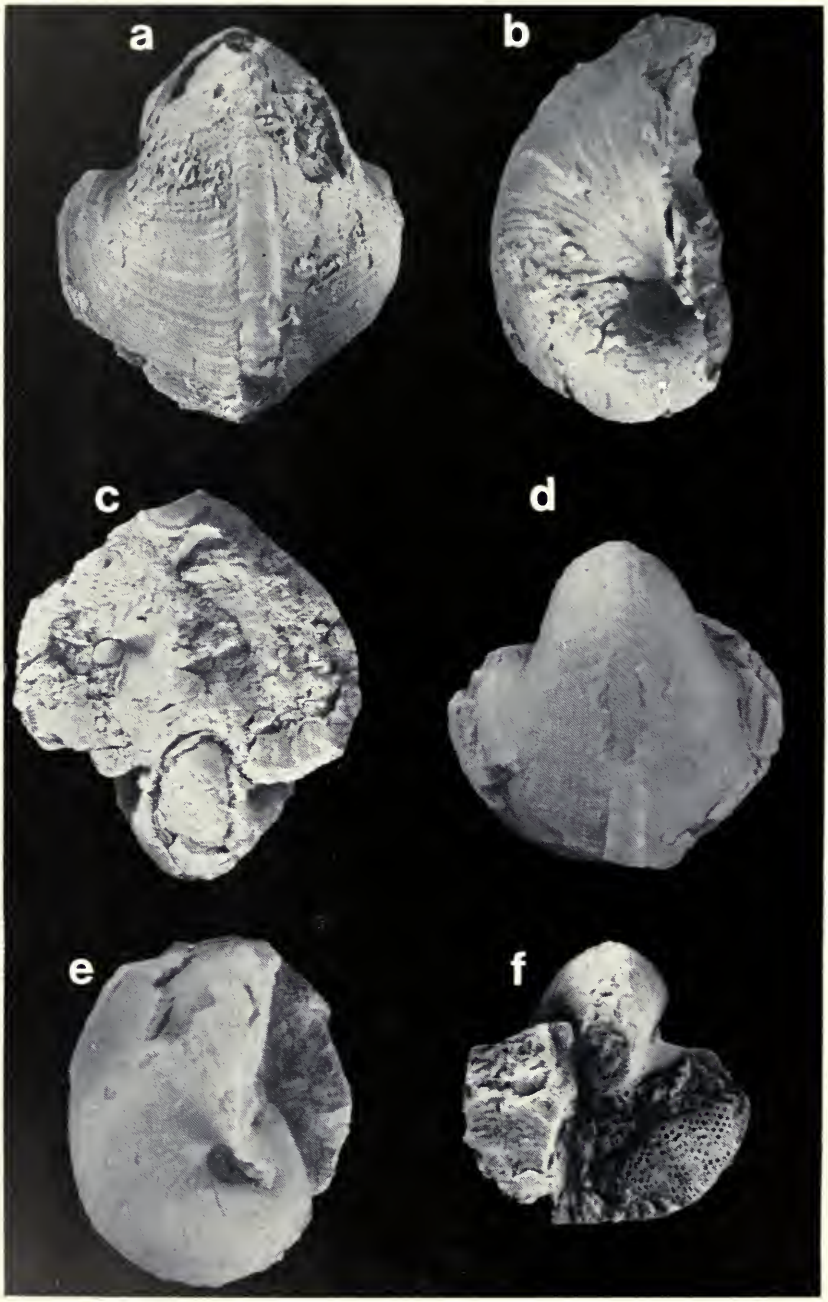
a
b
c
d
e
f

FIG. 14, *Continued.*—*Knightites* (*Retispira*) *ornatus* (S. Weller, 1920). **(g)** anterior dorsal view of rather immature specimen, × 2.3 (31692); **(h)** posterior view, × 2.3, same specimen; **(i)** left lateral view of holotype, × 2 (25417); **(j)** anterior dorsal view, × 2.5 (25318); **(k)** left lateral view, × 2.5, same specimen. All FMNH UC.

←

FIG. 14. *Knightites* (*Retispira*) *ornatus* (S. Weller, 1920). **(a)** anterior dorsal view, × 2 (56277); **(b)** right lateral view, × 2, same specimen; **(c)** apertural view, × 2, same specimen; **(d)** anterior dorsal view, × 2 (56276); **(e)** right lateral view, × 2, same specimen; **(f)** apertural view, × 2, same specimen.

Bucanopsis ornatus J. M. Weller, 1931, Ky. Geol. Surv., ser. VI, **36**, pl. 62, fig. 4.

Description.—Length and width probably nearly equal, umbilicus narrow, not covered by thickened shell. Aperture in mature individuals flared, more than three times as wide as the beginning of the last whorl. Rate of enlargement of shell regular in young stages but increasing in final whorl of mature specimens. Whorl profile sub-triangular at maturity, grading backward into more evenly rounded shape but elevation of central part is variously developed at comparable immature stages of different specimens. Depth of slit unknown. Selenizone prominent, nearly one-fourth as wide as shell at beginning of last whorl, convexly elevated, bounded by shallow grooves, becoming rapidly higher and resembling a keel near the aperture of mature specimens. Outer lip thin, unknown in detail, thickening very little laterally. Inductura of inner lip, covering about one-fifth of the last whorl, thickening only slightly internally. Growth lines closely spaced and delicate on young specimens, curving back moderately toward selenizone, becoming much stronger near aperture of mature shells, crossed by fine, closely spaced lirae that are relatively more conspicuous on smaller than on full grown specimens. Selenizone is marked by concave growth lines crossed by a few lirae fainter than those on either side.

Comparison.—Young specimens of this species closely resemble *Knightites* (*Retispira*) *monroensis* (S. Weller). The holotype of the latter species seems to be a rather immature specimen, and it differs from *K.* (*R.*) *ornatus* by having narrower whorls and more triangular outline at comparable growth stages. It resembles *K.* (*R.*) *textiliformis* (Gurley, 1883) (see J. M. Weller, 1929a, pp. 315–317, pl. 1, figs. 7a–7b, 8), a Pennsylvanian species from Missouri, in its ornamentation, but that species has broader whorls. It differs from *K.* (*R.*) *ourayensis* (Gurley, 1884) (see Girty, 1903, *Pattellostium ourayense*, pp. 471–473, pl. 10, figs. 10–10b), a Pennsylvanian form from Colorado, in having weaker ornamentation. The presence of similar ornamentation together with a strong keel recalls *K.* (*R.*) *marcouianus* (Geinitz, 1866, p. 7, pl. 1, fig. 12), another Pennsylvanian species from Nebraska, but the latter species has nodes on the keel.

Measurements.—Measurements are given in Table 10.

Material, stratigraphic position, and localities.—Fourteen specimens, including holotype and seven other specimens, from six localities. Holotype, by original designation FMNH UC 25417, S. Weller, 1920b, pl. 9, fig. 17; FMNH UC 56276, S. Weller, 1920b, pl.

TABLE 10.—Measurements (in mm.) of *Knightites* (*Retispira*) *ornatus* (S. Weller, 1920).

Specimen FMNH UC	L	W	Wb	H	Wa	La	Ws	L/W	W/Wb
56276	20.8	22.6	5.6	14.1	18.8	10.0	2.3	0.92	4.04
56277	26.4	24.0	6.5	18.9	20.9	13.4	2.6	1.10	3.70
25417	21.1	21.8	6.5	16.7	19.6	....	2.2	0.97	3.35
25318	14.7	12.4	3.9	10.7	12.2	5.6	1.4	1.19	3.18
30471	10.9	9.0	4.0	8.3	8.2	4.4	1.3	1.31	2.50
31692-1	22.6	19.7+	...	13.8+	....	....	2.4	....	....

9, figs. 19–20; FMNH UC 56277, S. Weller, 1920b, pl. 9, fig. 18; six specimens FMNH UC 31692. All Basal Golconda Limestone, Locality 13; FMNH UC 25109, Lower Okaw Limestone (Evansville Oolite), Locality 3; FMNH UC 26956, Renault Limestone, Locality 10; FMNH UC 25318, Lower Okaw Limestone, Locality 2; FMNH UC 30471 Golconda Limestone, Locality 9. In addition, seven specimens FMNH UC 25050 are tentatively assigned to this species, Lower Okaw (Marigold Oolite), Locality 14.

Subgenus **Cymatospira** Knight, 1942

Type species.—*Bellerophon montfortianus* Norwood and Pratten 1855.

Definition.—Lateral lips of aperture strongly expanded at final growth stage; collabral undulations prominent at intermediate growth stages especially on ridges over inhalant canals and along selenizone; parietal inductura with tooth-like extension into aperture (Knight et al., 1960, p. 184).

Stratigraphic range.—Lower Mississippian?, Upper Mississippian to Permian.

American Mississippian species.—*K.* (*Cymatospira*) *welleri*, n. sp., is the first species of *Cymatospira* unquestionably reported from the Mississippian formations of the United States. *Bellerophon branneri* S. Weller, 1897 (pp. 269–270, pl. 21, fig. 9), from Batesville Sandstone of Arkansas, and *Bellerophon alternodosus* Whitfield, 1882 (see Whitfield, 1895, p. 479, pl. 10, figs. 17–19), from Maxville Limestone of Ohio can only doubtfully be referred to this subgenus because of their poor preservation and inadequate illustration.

Discussion.—Subgenera *Knightites* (*Knightites*), *K.* (*Retispira*), *K.* (*Cymatospira*), and the genus *Patellilabia* are very similar to each other and differentiation of immature specimens is impossible. Immature individuals all possess revolving lirae and generally are similar in shape. Mature individuals of *K.* (*Retispira*) differ from those

of *K.* (*Cymatospira*) in lacking undulations on the whorl face on either side of the selenizone, in having a much less flared aperture, and only a thin inductura layer.

K. (*Cymatospira*) differs from *K.* (*Knightites*) by lacking prominent protuberances or open spines on either sides of the selenizone and by having more strongly flared, not undulating, apertural margins. It also is characterized by strong undulations on the whorl face on either side of the selenizone, a strongly flared but not undulating aperture, and a pad-like thickened parietal inductura within the aperture. Its revolving lirae are of two or more orders of strength. This subgenus differs from *Bucanopsis* by having strong undulations on the whorl face and a pad-like thickened inductura within the aperture, instead of an extension of inner apertural lips to form a ridge-like structure within the aperture. *K.* (*Cymatospira*) resembles *Patellilabia* in its similarly expanded aperture and thickened inductura, but the absence of undulations on the latter serves as a differentiating character.

Knightites (Cymatospira) welleri, new species. Figure 15.

Description.—Width seemingly about equal to length, or a little greater, umbilicus narrow, not closed by thickened shell. Enlargement regular, last whorl about three times the width of its predecessor. Whorl profile evenly rounded except for paired swellings located opposite each other on either side of the selenizone; swellings not present at young growth stages but appear and gradually become more acute on the mature portion of the shell at rates that vary between different individuals. Depth of slit not known. Selenizone about one-tenth width of shell, flat, slightly depressed, especially so between swellings. Mature aperture unknown so that proportions of complete shell are uncertain. Outer lip apparently thin, thickening very little laterally into umbilical region. Inductura of inner lip thickening rapidly backward to produce a hump within the aperture. Growth lines evenly spaced and regular except near aperture of mature specimens, turning back very little adjacent to selenizone. Revolving lirae abundant and closely spaced, generally more prominent than growth lines, especially near aperture of large individuals; new lirae introduced by implantation, gradually becoming stronger so that weak and strong lirae more or less alternate. Selenizone marked by gently concave growth lines more closely spaced than those on either side and crossed by three lirae similar to the flanking lirae.

TABLE 11.—Measurements (in mm.) of *Knightites* (*Cymatospira*) *welleri* n. sp.

Specimen FMNH UC	L	W	Wb	H	Wa	La	Ws
56283	....	16.8	7.0	14.0	....	...	1.0
56284	16.2	24.0	7.8	13.2	12.0	6.2	1.0
56285	16.8	17.4	...	....	....	...	1.0
56286	16.7	15.5	6.0	11.9	13.6	6.9	1.0
25319	16.4	16.7	6.8	11.4	14.6	7.0	1.0
30472-1	10.5	11.0	...	12.4	8.6	3.7	...

TABLE 12.—Ratios of *Knightites* (*Cymatospira*) *welleri* n. sp.

Specimen FMNH UC	L/W	Wa/La	W/Wb
56283	....	....	2.40
56284	0.68	1.94	3.08
56285	0.97	....	....
56286	0.77	1.97	2.58
25319	0.98	2.09	2.46
30472-1	0.95	2.32	....

Comparison.—This species probably is the precursor of *K.* (*C.*) *montfortianus* (Norwood and Pratten) from the Pennsylvanian. It differs principally by its less prominent swellings which do not appear at as early a growth stage and do not continue laterally as raised ridges into the umbilical regions and probably also by a much less flared aperture in mature specimens.

Measurements.—Measurements and ratios of measurements are given in Tables 11 and 12.

Material, stratigraphic positions, and localities.—Twenty-four specimens from five localities. Holotype: FMNH UC 25319, five specimens FMNH UC 56283–56287, Lower Okaw Limestone, Locality 2; one specimen FMNH UC 56288 and seven specimens FMNH UC 30472, Golconda Limestone, Locality 9; six specimens FMNH UC 30338 and two specimens FMNH UC 30339, Glen Dean Limestone, Locality 12; one specimen FMNH UC 25107, Lower Okaw Limestone, Locality 11; one specimen FMNH UC 25038, Lower Okaw (Marigold Oolite), Locality 14.

Genus **Patellilabia** Knight, 1945

Patellilabia Knight, 1945, Jour. Paleontol., **19**, no. 4, p. 336; Knight et al., 1960, Treat Invert. Paleontol., part I, p. 184; Yochelson, 1960, Bull. Amer. Mus. Nat. Hist., **119**, p. 243.

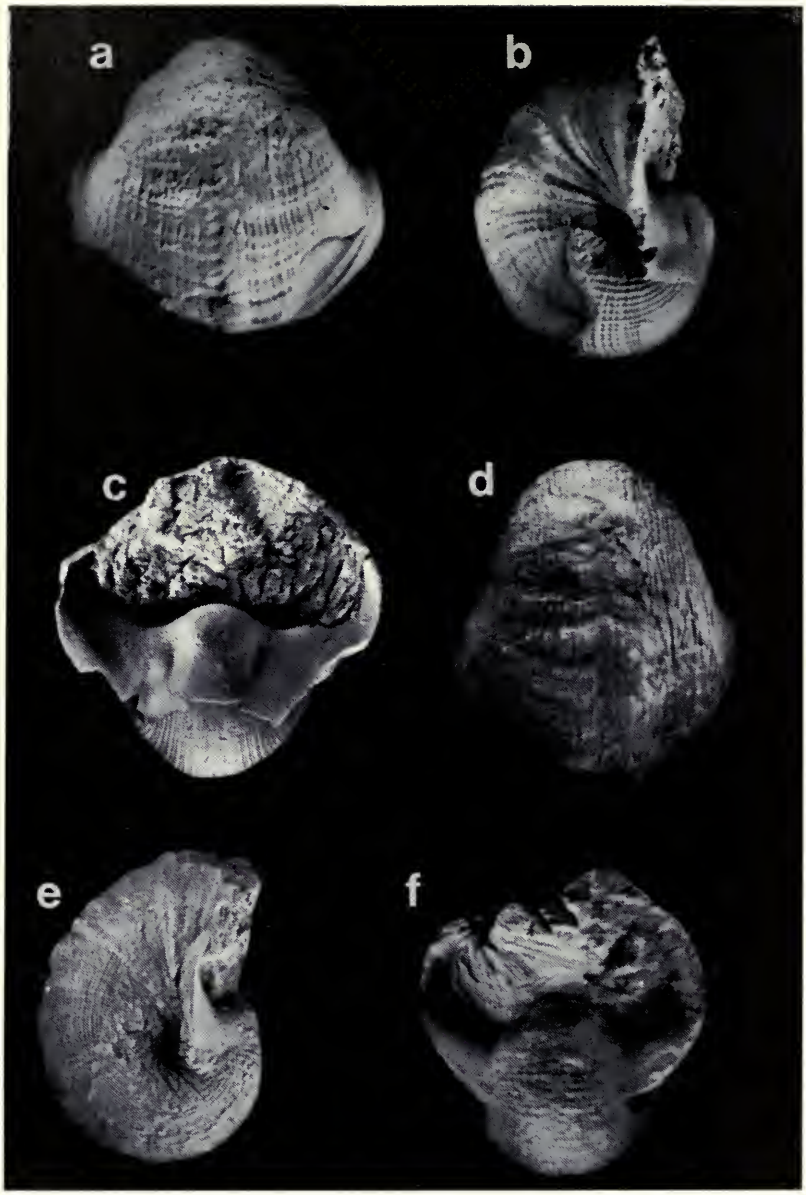

FIG. 15. *Knightites* (*Cymatospira*) *welleri* n. sp. **(a)** anterior dorsal view of holotype (25319); **(b)** right lateral view, same specimen; **(c)** apertural view, same specimen; **(d)** anterior dorsal view (56286); **(e)** right lateral view, same specimen; **(f)** apertural view, same specimen.

FIG. 15, *Continued.*—*Knightites* (*Cymatospira*) *welleri* n. sp. (g) anterior dorsal view (56285); (h) anterior dorsal view (56284); (i) apertural view, same specimen; (j) dorsal view (30472-2); (k) left lateral view, same specimen; (l) anterior dorsal view (56283). All FMNH UC. All × 2.5.

Type species.—*Patellilabia tentoriolum* Knight, 1945.

Definition.—Aperture margins progressively expanding backward and at sides; parietal inductura with forward projecting tooth; ornamented with numerous spiral threads and growth lines (Knight et al., 1960, p. 184).

Stratigraphic range.—Mississippian to Lower Permian.

American Permo-Carboniferous species: Only six species are referred to *Patellilabia*, two from the Pennsylvanian, two from the Upper Mississippian, one from the Lower Mississippian, and one from Lower Permian. *P. tentoriolum* Knight, 1945 (pp. 337–338, pl. 49, figs. 3a–f) from the Upper Pennsylvanian of eastern Kansas is the type. *Bellerophon ellipticus* McChesney, 1859, from the Pennsylvanian of Illinois is fairly well-figured (McChesney, 1859, pp. 58–59; 1865, pl. 3, figs. 1, 2), but the types are lost (Yochelson, 1960, p. 228). *Bellerophon scriptiferus* (White, 1862), which is rather poorly figured by S. Weller (1900, pp. 115–116, pl. 6, fig. 6), is from the Lower Mississippian of Iowa, and *Patellostium* (*Patellilabia*) *montfortianum* var. *intermedia* Elias, 1958 (p. 5, pl. 1, figs. 1, 2) from the Upper Mississippian of southern Oklahoma was described from external molds. *Patellilabia laevigata* (Girty, 1910) from the basal limestone of the Fayettesville Shale, Arkansas was redescribed by Yochelson (1969b, pp. 27–28, pl. 5, figs. 44–48).

Patellilabia junior Yochelson, 1960, is from Lueders Limestone (Permian) from Southwestern United States. *Patellilabia* sp. undet. from Pennsylvanian of Ohio is described (Sturgeon, 1964a, pp. 201–202, pl. 32, fig. 7).

Patellilabia chesterensis, new species. Figure 16.

Description.—Width of aperture somewhat greater than length, umbilicus open, narrow. Enlargement regular through first half of last whorl where flaring of aperture begins, forward slope becoming nearly straight and descending at angle of about 45 degrees when lateral expansion occurs. Aperture unknown, slit probably very shallow. Selenizone narrow, about one-fifteenth of width of shell at last half whorl, very slightly raised above adjacent surface but becoming a little higher forward, not bordered by intermittent swellings. Outer lip evidently very thin, expanded laterally and continued backward as a horizontal train of unknown length. Nature of inductura within aperture unknown. Surface of shell nearly smooth, growth lines very faint, turning back very little as they approach

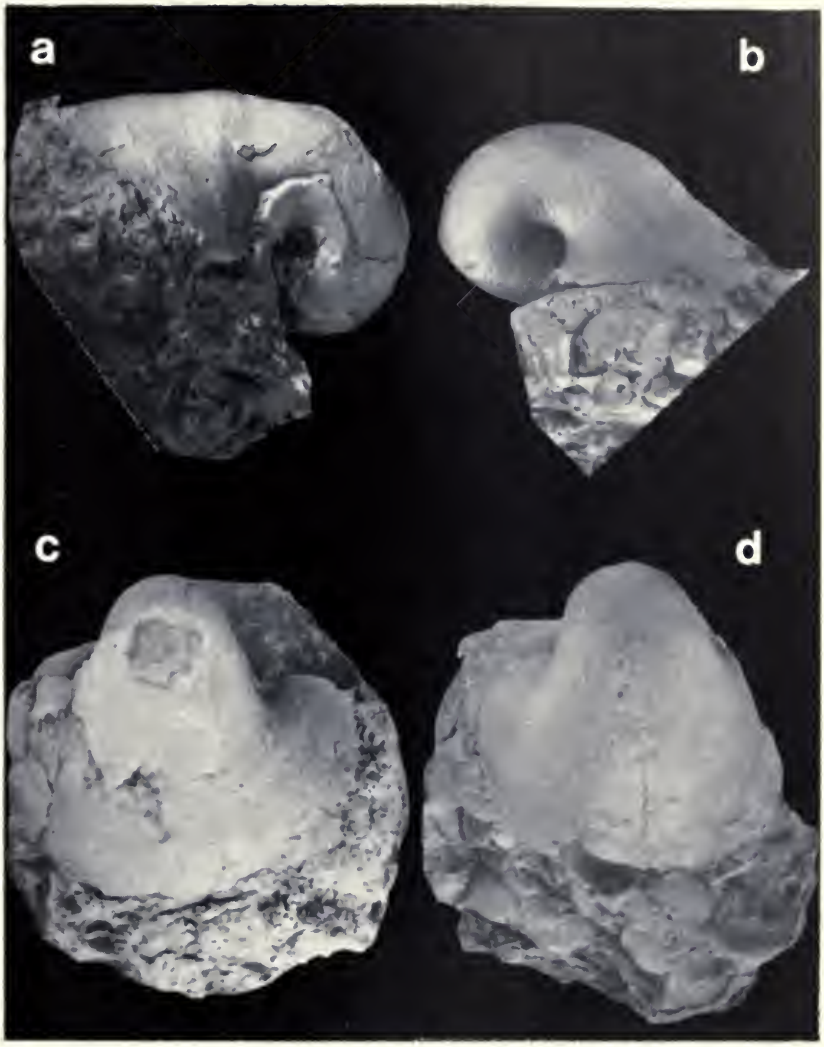

FIG. 16. *Patellilabia chesterensis* n. sp. **(a)** left lateral view (30337); **(b)** right lateral view of holotype (25321); **(c)** anterior dorsal view (30337); **(d)** anterior dorsal view of holotype (25321). All FMNH UC. All × 2.

selenizone. Very faint revolving grooves or lirae suggested near umbilicus on one individual. Selenizone marked by very faint concave growth lines.

Comparisons.—*Patellilabia chesterensis* differs from P. *tentoriolum* Knight, 1945 (pp. 337–338, pl. 49, figs. 3a–f), *P. ellipticus* (McChes-

ney, 1859, pp. 58–59; see 1865, pl. 3, figs. 1, 2), and *P. montfortianum* var. *intermedia* (Elias, 1958, p. 5, pl. 1, figs. 1, 2) by having lesser and weaker revolving ornamentation, and from *P. scriptiferus* (White) by the absence of wrinkles at outer margin of aperture and less closely coiled whorls.

Measurements.—Measurements are given in Table 13.

TABLE 13.—Measurements (in mm.) of *Patellilabia chesterensis* n. sp.

Specimen FMNH UC	L	W	Wb	H	Ws	L/W	L/H	W/Wb
25321	16.6	19.6	4.8	13.0	0.7	0.85	1.28	4.08
30337	19.7	27.2	7.4	19.2	...	0.73	1.03	3.68

Material, stratigraphic positions, and localities.—Two specimens, one completely exfoliated, and two fragmentary steinkerns from four localities. Holotype: FMNH UC 25321, Lower Okaw Limestone, Locality 2; FMNH UC 30337, Glen Dean Limestone, Locality 12; FMNH UC 26683, Menard Limestone, Locality 6; FMNH UC 31039, Glen Dean Limestone, Locality 15.

Suborder Macluritina Cox and Knight, 1960
Superfamily *Euomphalacea* de Koninck, 1881
Family *Euomphalidae* de Koninck, 1881

Genus **Straparollus** Montfort, 1810

Straparollus, Yochelson, 1956, Bull. Amer. Mus. Nat. Hist., **110**, p. 196; Knight et al., 1960, Treat. Invert. Paleontol., part I, p. 192.
Straparolus, Knight, 1941, Geol. Soc. Amer., Sp. Paper 32, p. 337.

Type species.—*Straparollus dionysii* Montfort, 1810.

Definition.—Shape variable, ranging from moderately high conispiral to discoidally hyperstrophic. Outer-upper angulation bears a channel, probably of exhalent function, or slight sinus.

Stratigraphic range.—Silurian to Middle Permian.

Subgenus **Euomphalus** Sowerby, 1814

Type species.—*Euomphalus pentangulatus* Sowerby, 1814.

Definition.—Discoidal to low-spired gastropods with a distinct angulation on the outer edge of the upper whorl surface. Spire depressed in juvenile stage, with one or more whorls rising above discoidal protoconch. Distinct angulation present at the outer edge to give a sub-elliptical whorl section. Base slightly flattened. Upper

and basal angulations sometimes bearing sharp keels; in some species nodes present on either upper or lower angulation, or on both.

Stratigraphic range.—Silurian to Middle Permian.

Remarks.—Of eight taxa of Euomphalidae described in this paper, seven belong to the subgenus *Euomphalus* and only one definitely belongs to the subgenus *Straparollus*. In addition, however, there are two other doubtful *Straparollus* forms, which are not described because of their imperfect preservation. The overall collection shows the conspicuous predominance of the subgenus *Euomphalus* over the subgenus *Straparollus*. Other Paleozoic subgenera such as *Philoxene*, *Serpulospira*, *Leptomphalus*, and related genera like *Amphiscapha* and *Cyclicioscapha* are not represented.

American Mississippian species.—The following Mississippian species are referred to the subgenus *Euomphalus:*

Straparollus angularis S. Weller, 1900 (p. 110, pl. 6, figs. 13, 14), Kinderhook of Iowa.

Straparollus (*Euomphalus*) *brooksensis* Yochelson and Dutro, 1960 (p. 133, pl. 12, figs. 15, 20–23), Lower Mississippian of Northern Alaska.

Euomphalus latus Hall, 1858 (p. 605, pl. 12, fig. 7a, b), Burlington Limestone, Illinois and Iowa.

Euomphalus luxus White, 1877 (pp. 94–95, pl. 5, figs. 13a, b), Waverly Group, Utah.

Euomphalus planodorsatus Meek and Worthen, 1861 (p. 462; see 1866b, pp. 302–303, pl. 24, figs. 2a-c), Chester Limestone, Illinois and Missouri.

Euomphalus subplanus Hall, 1852 (p. 414, pl. 2, figs. 7a, b) Mississippian, Utah.

Straparollus similis Meek and Worthen, 1862 (p. 145; see 1866b, pp. 285–286, pl. 19, figs. 4a, b), St. Louis Limestone, Illinois.

Straparollus similis var. *planus* Meek and Worthen, 1862 (p. 146; see 1866b, p. 286, pl. 19, figs. 5a–c), St. Louis Limestone, Illinois.

Euomphalus (*Straparollus*) *utahensis* Hall and Whitfield, 1877 (pp. 259–260, pl. 4, figs. 20–23), Waverly Group, Utah.

Straparollus (*Euomphalus*) sp. A. Easton, 1962 (p. 99, pl. 13, fig. 14), Upper Mississippian, Central Montana.

Straparollus (*Euomphalus*) sp. B. Easton, 1962 (p. 99, pl. 13, fig. 15), Upper Mississippian, Central Montana.

Grouping of the species.—The seven taxa of the subgenus *Euomphalus* described in this paper vary considerably, although most of them are smooth without rugosity or heavy growth lines. These forms, in a very broad way, can be divided into three groups based mainly on differences in general shape and outline of the final whorl section. The apertures of most of the specimens of the subgenus *Euomphalus* considered in this paper are broken and growth lines too faint to be observed clearly. Therefore, it is impossible to utilize the aperture as a differentiating character.

The taxa of *Euomphalus* described here are separated into the following groups:

1. Group of *Straparollus* (*Euomphalus*) *planidorsatus:* The forms in this group are characterized by very low to moderately high spires, low, thin upper angulation, and sub-pentagonal final whorl outline. The upper surface of the final whorl may be either flattened or slightly inclined upwards with inconspicuous concavity. The lower angulation is situated at about the middle of the base, and the aperture generally is higher or almost equal to its width. *S.* (*E.*) *planidorsatus, S.* (*E.*) sp. indet. 1, and *S.* (*E.*) sp. indet. 2 are included.

2. Group of *Straparollus* (*Euomphalus*) *illinoisensis:* This group is characterized by a concave spire. The umbilicus is generally very wide. Upper angulation of the final whorl is relatively pronounced, smooth, and generally rounded. Final whorl outline is sub-transverse, its width is greater than height, and its upper surface is inclining upward. The lateral face usually is conspicuously convex. *S.* (*E.*) *illinoisensis* and *S.* (*E.*) sp. indet. 3 are included.

3. Group of *Straparollus* (*Euomphalus*) sp. indet. 5. This group is characterized by a flattened spire, generally horizontal upper surface with subtransverse final whorl, and narrow and extended upper angulation. The upper angulation may be either vertical or nearly horizontal. The umbilicus is very deep. *S.* (*E.*) sp. indet. 4 and *S.* (*E.*) sp. indet. 5 are included.

Straparollus (Euomphalus) planidorsatus (Meek and Worthen, 1861). Figure 17.

Euomphalus planodorsatus Meek and Worthen, 1861, Proc. Nat. Sci., Phila., **12**, p. 462.

Euomphalus perspectivus Swallow, 1863, Trans. St. Louis Acad. Sci., **2**, pp. 98–99.

Straparollus planidorsatus Meek and Worthen, 1866a, Geol. Surv. Ill., **2**, pp. 302–303, pl. 24, figs. 2a–c.

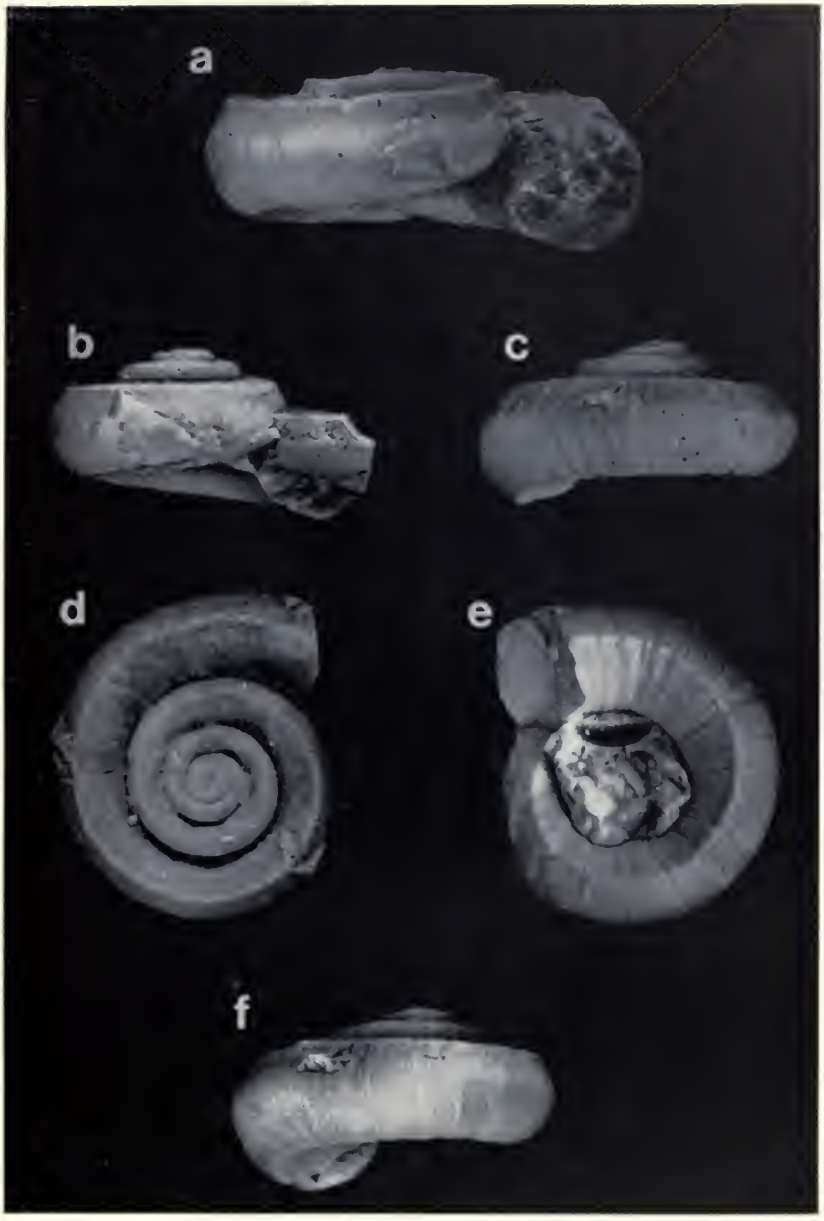

FIG. 17. *Straparollus (Euomphalus) planidorsatus* (Meek and Worthen, 1861). **(a)** apertural view of a mature specimen (25219-3); **(b)** apertural view of a younger specimen (25314-4); **(c)** dorsal view, same specimen; **(d)** apical view, same specimen; **(e)** umbilical view, same specimen; **(f)** dorsal view (25314-1).

Straparollus planidorsatus Keyes, 1894, Mo. Geol. Surv., **5**, p. 160.

Euomphalus planidorsatus Girty 1915a, Bull. U. S. Geol. Surv., **544**, p. 178.

Euomphalus planidorsatus Girty, 1915b, Bull. U. S. Geol. Surv., **595**, p. 38, pl. 2, figs. 1, 2.

Straparollus planidorsatus Snider, 1915, Bull. Okla. Geol. Surv., **24**, p. 117.

Description.—Shells medium sized, extremely low-spired with a distinct angulation on the outer edge of the upper whorl surface. Protoconch consists of about 1½ flatly coiled whorls. Second whorl (neanic) rises above the protoconch and is sharply rounded. Third whorl is lower than the previous one and starts to develop angularity at the outer edge of its upper surface. This angularity is well developed on the fourth whorl, whose upper surface is flat and almost horizontal, with only a slight slope towards the axis. Upper surface of fifth whorl flat and horizontal, its upper angulation strongly developed at the outer edge, in some individuals protruding very slightly upwards. Lateral face rather sharply rounded to the sharply rounded basal angulation at the middle of the under side; from there the surface rounds into the umbilicus which is deep and wide with slightly convex walls. Final whorl sub-pentagonal, embraces the penultimate whorl at or close below periphery on matured specimens. Sutures not incised, but well defined. Ornament absent. Growth lines thin, rather crowded, almost straight, swinging very slightly backward on the upper surface between suture and outer angulation, swinging slightly backward with somewhat more convexity on the convex lateral face, and concave forward on the lower surface and umbilical walls. Shell composed of two layers, outer layer thin, inner one thick and lighter colored.

Comparisons.—*Straparollus* (*Euomphalus*) *planidorsatus* is closely similar to *S.* (*E.*) *similis* (Meek and Worthen) in general shape of shell and whorls. The latter species differs in being markedly smaller with somewhat higher spire and narrower umbilicus. *S.* (*E.*) *planidorsatus* differs from *S.* (*E.*) *pentangulatus* Sowerby, 1814 (see Knight, 1941, p. 122, pl. 73, figs. 4a–d), from the Lower Carboniferous of Ireland, in having a flattened and horizontal upper surface. It resembles *S.* (*E.*) *angularis* (S. Weller 1900), but the latter species has

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FIG. 17, *Continued—Straparollus* (*Euomphalus*) *planidorsatus* (Meek and Worthen, 1861). **(g)** apical view, same specimen; **(h)** apical view (25314-2); **(i)** apertural view of a well-matured specimen (25219-1); **(j)** dorsal view, same specimen; **(k)** apical view, same specimen; **(l)** umbilical view, same specimen. All FMNH UC. All × 4.

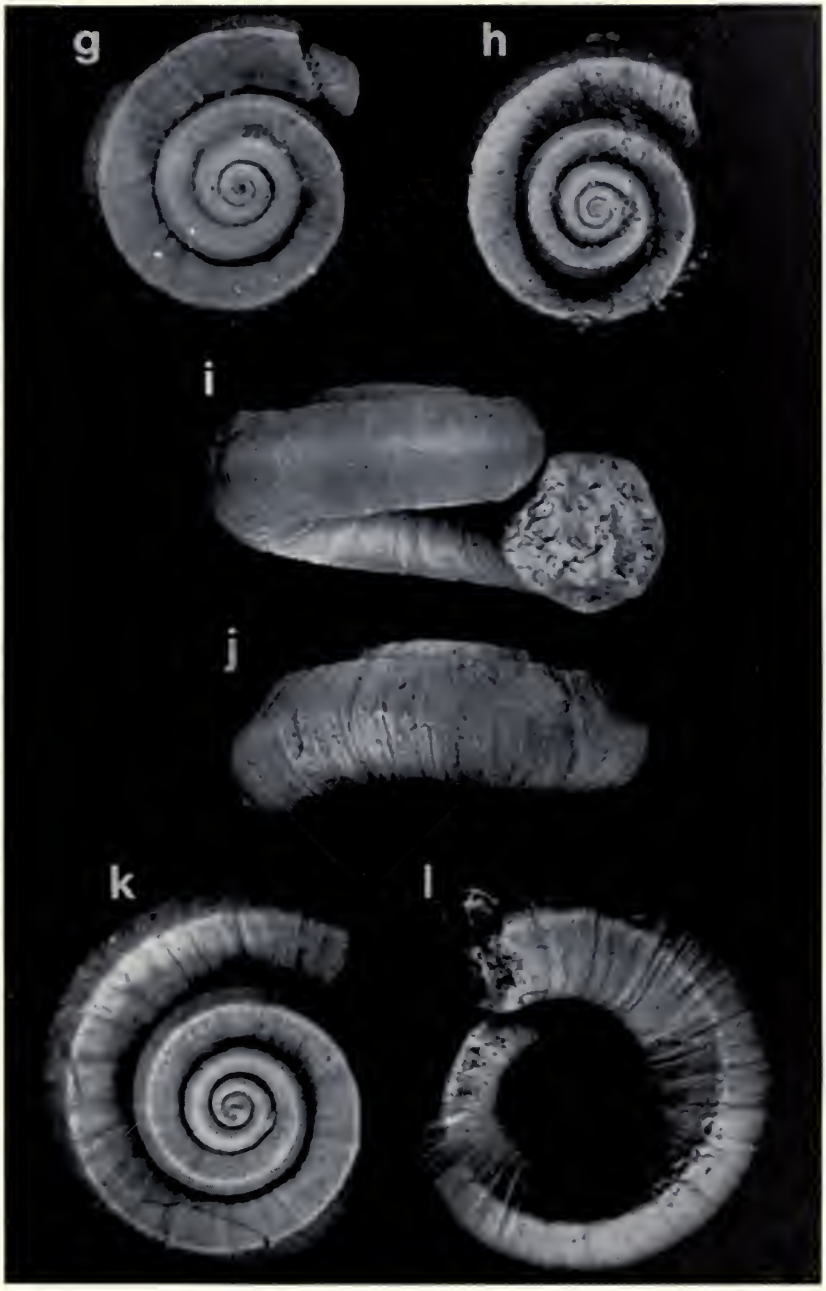
g
h
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TABLE 14.—Measurements (in mm.) of *Straparollus* (*Euomphalus*) *planidorsatus* (Meek and Worthen, 1861).

Specimen FMNH UC	W	H	Wa	Ha	Nw	Wa/Ha	W/H
25219-1	15.2	7.9	5.6	5.4	5.5	1.04	1.92
25219-2	14.0	6.8	5.6	4.9	5.5	1.14	2.06
25219-3	14.6	7.2	5.6	5.3	5.0	1.06	2.03
25219-4	14.3	7.0	5.1	5.0	5.0	1.02	2.04
25219-5	12.8	...	...	...	5.5	....	....
25219-6	11.7	6.5	4.3	4.3	5.5	1.00	1.80
25314-1	13.5	6.8	4.5	4.4	5.5	1.02	1.99
25314-2	10.8	5.8	4.0	4.0	5.0	1.00	1.86
25314-3	10.0	...	...	...	6.0	....	....
25314-4	11.8	6.5	4.2	4.2	5.0	1.00	1.82
25314-5	11.2	...	...	...	5.5	....	....
25314-6	9.4	5.0	...	...	5.0	....	1.88
25314-7	10.9	5.7	4.2	4.0	5.5	1.05	1.91
Total	158.0	65.2	43.1	41.5	...	9.33	19.31
Mean	12.2	6.5	4.8	4.6	...	1.04	1.93

a stronger upper angulation and the upper surface is not horizontal. It also resembles *S.* (*E.*) *laxus* (White, 1877), a species described from near the base of the Mississippian strata in Utah, in its general form, but the figures and descriptions of that species do not reveal the sharp basal angulation at the center of the base, and its growth lines on the upper surface are slightly sinuous.

Measurements.—Measurements are given in Table 14.

Variation.—Width and height ratios are somewhat variable. Usually shells with lower spires have less overlapping final whorls.

Material, stratigraphic positions, and localities.—Nineteen specimens, ranging from immature to mature stages of development, from five localities, all in Illinois. Most of the specimens are well preserved; six specimens FMNH UC 25219, Lower Okaw (Golconda Limestone), Locality 1; seven specimens FMNH UC 25314, Lower Okaw Limestone, Locality 2; three specimens FMNH UC 25123, Lower Okaw (Evansville Oolite), Locality 3; two specimens FMNH UC 26878, Paint Creek Shale, Locality 4; one specimen FMNH UC 30065, Renault Limestone, Locality 5.

Straparollus (Euomphalus) illinoisensis new species. Figure 18.

Description.—Shells medium-sized, planospirally coiled with angulations at outer whorl face. Spire slightly concave, base much more so. Protoconch unknown. Each whorl rises higher than the previous one. Whorl section sub-pentagonal. Suture not excavated, but distinctly impressed between the outer whorl and the carina of

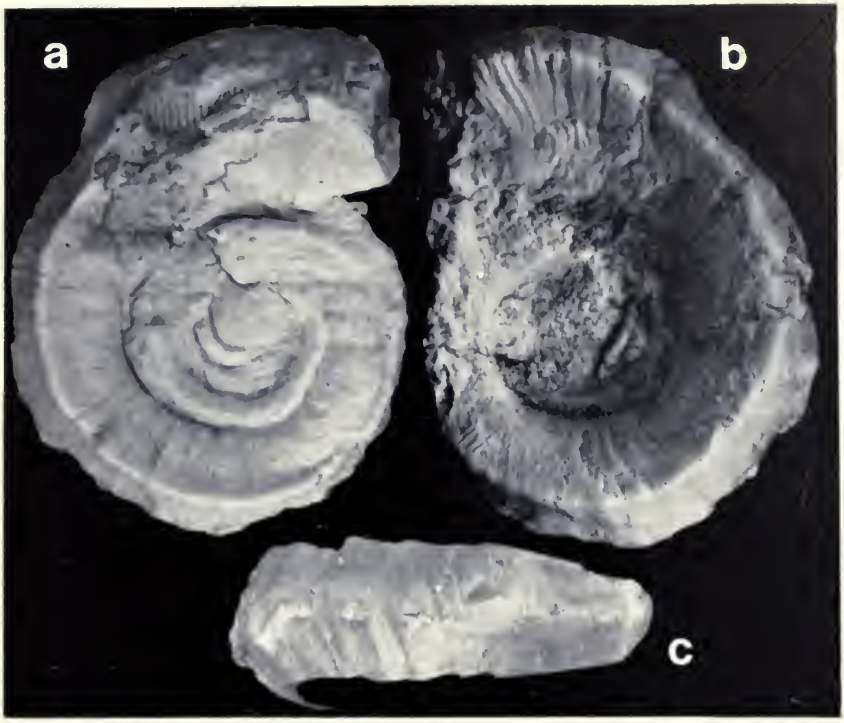


FIG. 18. *Straparollus (Euomphalus) illinoisensis* n. sp. **(a)** apical view of holotype (FMNH UC 56289); **(b)** umbilical view, same specimen; **(c)** dorsal view, same specimen. All × 2.

the inner whorl. Umbilicus extremely wide and relatively deep. Upper surface slightly inclining inward, generally convex except near the upper angulation where it is slightly concave. Upper angulation smooth, sub-rounded, distinctly elevated. Lateral face raised in the middle between concave bands. Lower angulation sub-rounded, not as strong as the upper one. Basal surface flattened sloping inward at an angle of about 45 degrees. Umbilical walls nearly flat, sloping steeply towards the axis of coiling. Ornament absent except for moderately coarse, irregularly spaced growth lines, which are slightly convex forward on the upper surface, straight on the upper angulation, swinging slightly backward on the lateral face and more strongly so on the lower surface where they change direction and swing forward. Shell seemingly thin.

Comparison.—*Straparollus (Euomphalus) illinoisensis* suggests *S. (E.) subrugosus* Meek and Worthen, (1873, p. 607, pl. 29, figs. 11a–c),

but is without ornamentation on the upper angulation, and the base is much more concave than the spire. It closely resembles *S.* (*E.*) sp. A. Easton, 1962, but Easton's species is too poorly preserved for comparison. It also closely resembles *S.* (*E.*) *utahensis* (Hall and Whitfield, 1877), a Lower Mississippian form, especially as redescribed by Yochelson (1962, pp. 76–77, pl. 17, figs. 22, 23), but its upper surface is convex rather than concave and the pattern of growth lines is different.

Measurements.—Measurements are given in Table 15.

TABLE 15.—Measurements (in mm.) of *Straparollus* (*Euomphalus*) *illinoisensis* n. sp.

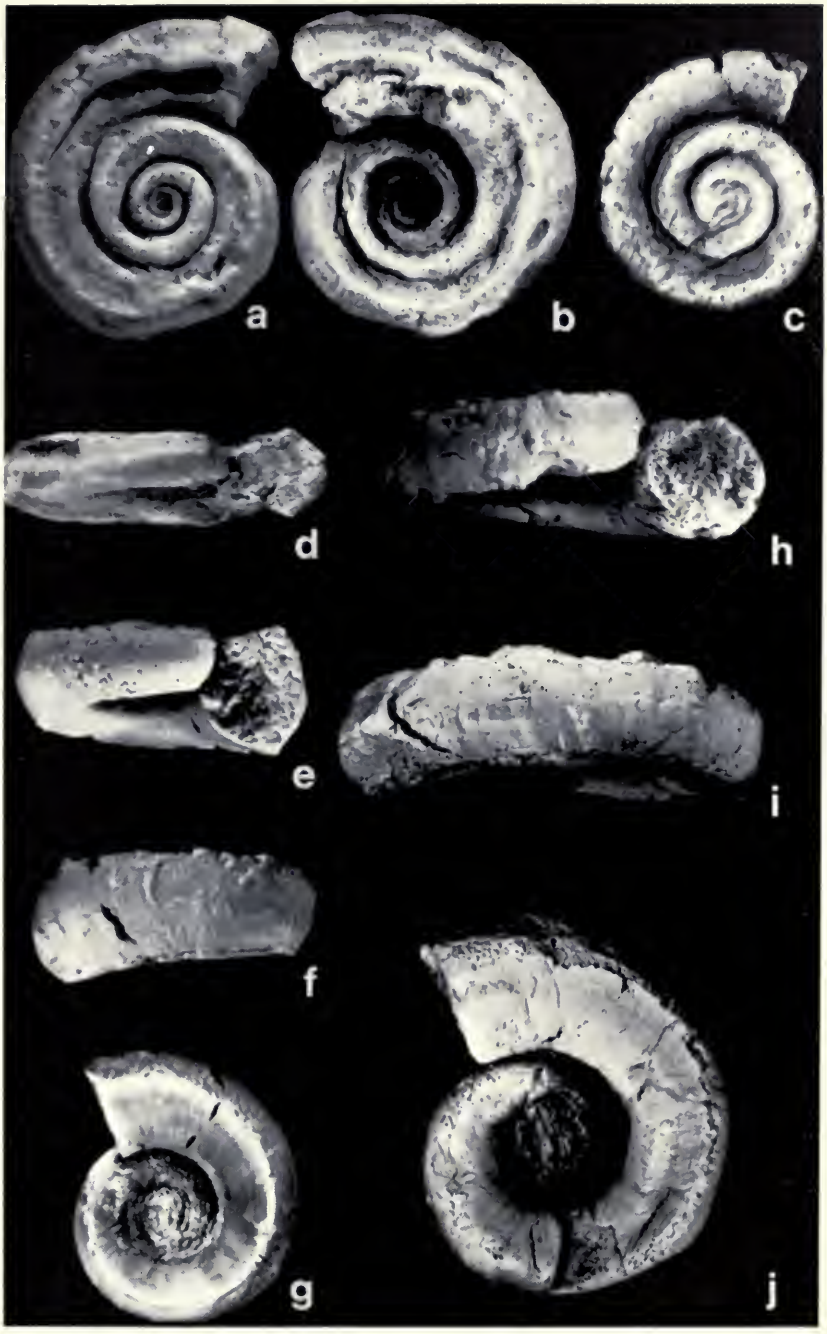
Specimen FMNH UC	W	H
56289	30.4	10.4
25450-2	25.6	8.4
25450-3	19.8±	6.0+
25450-4	28.0	8.9+

Material, stratigraphic positions, and localities.—Five specimens from a single locality. Only one is fairly well preserved and shows its external characters. Holotype: FMNH UC 56289; four specimens, FMNH UC 25450, Menard Limestone, Locality 6.

Straparollus (Euomphalus) sp. indet. 1. Figure 19.

Description.—Shells medium-sized, spire very low with the upper whorl surface flat and slanting slightly inward; probably about four whorls, except in the protoconch each successively a little lower than the preceding one. Whorl section somewhat arched, flattened above. Suture angular, not excavated. Umbilicus wide and deep with nearly vertical walls. Final whorl embracing the penultimate whorl above periphery. Upper whorl face almost flat except close to the outer margin where it is inclined towards the axis of coiling at an angle of about 10 degrees. Upper angulation smooth, distinct, but not highly elevated. Outer whorl face regularly convex, except close to the bounding angulations where it is somewhat flattened. Lower angulation smooth, slightly narrower than the upper angulation. Lower

FIG. 19. *Straparollus* (*Euomphalus*) sp. indet. 1 **(a)** apical view, × 5, (30793); **(b)** umbilical view, × 5, same specimen; **(c)** apical view, × 4 (30925-4); **(d)** apertural view, × 5 (30793-1); **(e)** apertural view, × 4 (30925-4); **(f)** dorsal view, × 4, same specimen; **(g)** umbilical view, × 4, same specimen; **(h)** apertural view, × 3 (30925-1); **(i)** dorsal view, × 3, same specimen; **(j)** umbilical view, × 3, same specimen. All FMNH UC.


a
b
c
d
h
e
i
f
g
j

surface flattened, sloping moderately towards the umbilicus. Ornament absent except for fine growth lines, not evident on upper surface, swinging slightly backward on the lateral face, and concave forward on the lower surface and umbilical walls.

Comparisons.—*Straparollus* (*Euomphalus*) sp. indet. 1 differs from *S.* (*E.*) *planidorsatus* by having a lower spire, inclined upper whorl surface, and less convex lateral face. The nature of upper angulation and the flattened and inclined upper surface resembles *S.* (*E.*) *angularis* (S. Weller, 1910), but the latter is readily distinguished by its much higher spire.

Measurements.—Measurements are given in Table 16.

TABLE 16.—Measurements (in mm.) of *Straparollus* (*Euomphalus*) sp. indet. 1.

Specimen FMNH UC	W	H	Wa	Ha	W/H	Wa/Ha
30925-1	17.9	8.7	6.2	5.7+	2.06	1.36
30925-2	13.2	6.1	...	5.0+	2.16	....
30925-3	11.4	5.3	...	4.2+	2.15	....
30925-4	9.5	4.7	3.5	4.2	2.02	0.83
30487-1	8.4	...	...	...	....	....
30487-2	10.9	2.4+	...	...	....	....
30793-1	8.8	2.3	3.3	2.3	2.83	1.43
30793-2	6.9	2.4	...	...	2.87	....

Materials, stratigraphic positions, and localities.—Nine specimens from three localities. Two specimens FMNH UC 30793, Renault Limestone, Locality 7; five specimens FMNH UC 30925, Kinkaid Limestone, Locality 8; two specimens FMNH UC 30487, Golconda Limestone, Locality 9.

Straparollus (Euomphalus) sp. indet. 2. Figure 20.

Comparisons: This form resembles *S.* (*E.*) *planidorsatus* in most respects, but differs from it by having a higher spire and higher whorls. The growth lines on the lateral surface are less curved and swing slightly backward. This species is distinguished from *S.* (*E.*) sp. indet. 3 by its much higher spire and steeper basal face. It differs from *S.* (*E.*) *umbilicatus* Meek and Worthen, 1861 (pp. 462–463; 1866b, pp. 362–363, pl. 29, figs. 1a–c), a Pennsylvanian species, by its lower spire and narrower umbilicus.

Measurements.—Measurements (in mm.) on two specimens are:

Specimen	Width	Height
1	12.9	7.8
2	9.7	7.0

FIG. 20. *Straparollus (Euomphalus)* sp. indet. 2. **(a)** anterior dorsal view, × 3.5 (30604-1); **(b)** apertural view, × 3.5, same specimen; **(c)** apical view, × 3.5, same specimen; **(d)** umbilical view, × 3.5, same specimen; **(e)** umbilical view, × 4 (30604-2). All FMNH UC.

Material, stratigraphic position, and locality.—Three poorly preserved specimens FMNH UC 30604, Kinkaid Limestone, Locality 16.

Straparollus (Euomphalus) sp. indet. 3. Figure 21.

Comparison.—This form resembles *S. (E.) planidorsatus* in most respects, but is nearly planospiral with a wider umbilicus. The upper whorl surface slopes down and inward at an angle of about 40 degrees. Umbilical walls are low but steep. It differs from *S. (E.)* sp. indet 2 by its lower spire, shorter whorls, and shallower umbilicus.

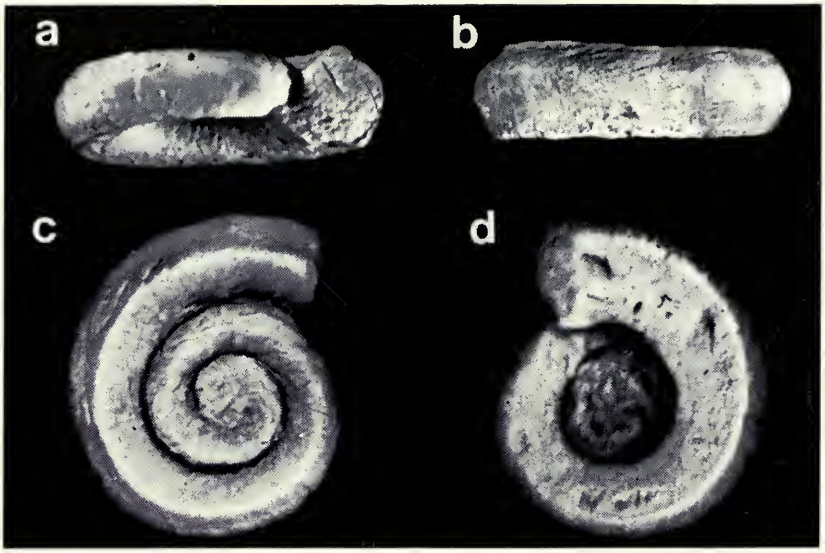


FIG. 21. *Straparollus (Euomphalus)* sp. indet. 3. **(a)** apertural view (FMNH UC 56290); **(b)** dorsal view, same specimen; **(c)** apical view, same specimen; **(d)** umbilical view, same specimen. All × 4.

Measurements (in mm.).—Width—10.6; height—3.5; width of aperture—3.8; height of aperture—3.5.

Material, stratigraphic position, and locality.—A single specimen FMNH UC 56290, Paint Creek Shale, Locality 4.

Straparollus (Euomphalus) sp. indet. 4. Figure 22.

Comparisons.—This form closely resembles *S.* (*E.*) sp. indet. 1 except its spire is flattened and the upper angulation is distinct,

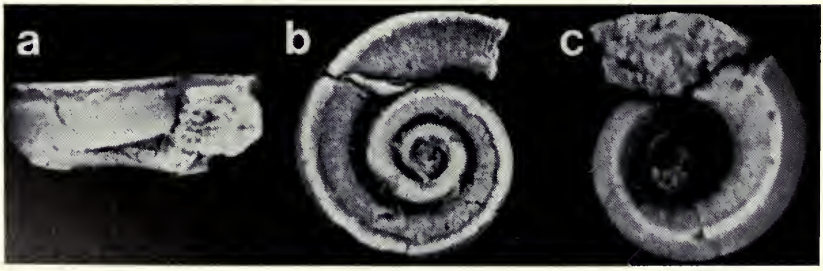


FIG. 22. *Straparollus (Euomphalus)* sp. indet. 4. **(a)** apertural view (FMNH UC 25046); **(b)** apical view, same specimen; **(c)** umbilical view, same specimen. All × 7.

raised, vertical, and located at outermost edge of the whorl. It also resembles *S.* (*E.*) sp. indet. 5, and may be a juvenile of that form. This species possesses characters intermediate between the subgenus *Euomphalus* and the genus *Planotectus*. The absence of a rounded base and the presence of a basal angulation eliminates it from *Planotectus*.

Measurements (in mm.).—Width—4.7; height—1.8.

Material, stratigraphic position, and locality.—One small, probably immature specimen FMNH UC 25046, Lower Okaw (Marigold Oolite), Locality 14.

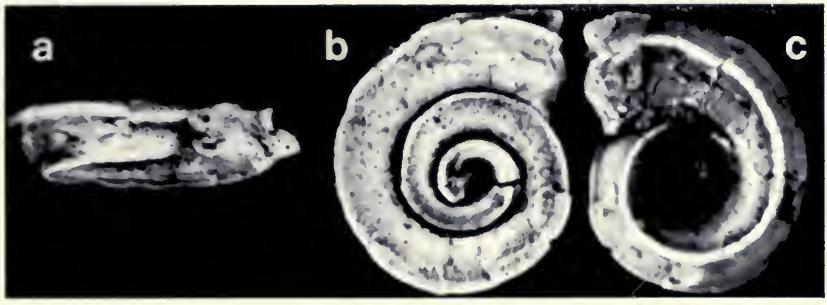


FIG. 23. *Straparollus* (*Euomphalus*) sp. indet. 5. **(a)** apertural view (FMNH UC 25146); **(b)** apical view, same specimen; **(c)** umbilical view, same specimen. All × 5.

Straparollus (Euomphalus) sp. indet. 5. Figure 23.

Comparisons.—This form resembles *S.* (*E.*) sp. indet. 4, but the upper angulation is horizontal and projects outward. The outer whorl surface is slightly convex, but slants inward at an angle of about 50 degrees. The lower angulation, as in *S.* (*E.*) sp. indet. 4, is at the middle of the lower whorl face, but more distinct. The umbilical walls are steep and relatively narrow. It differs from *Planotectus cymbellatus* Yochelson, 1956, (p. 228, pl. 13, figs. 20–24), a Permian species, by having a basal angulation and a more horizontal upper angulation.

Measurements (in mm.).—Width—7.0; height—2.0.

Material, stratigraphic position, and locality.—A single specimen FMNH UC 25146, Lower Okaw (Golconda), Locality 17.

Subgenus **Straparollus** de Montfort, 1810

Type species.—*Straparolus dionysii* deMontfort, 1810.

Definition.—Trochiform to depressed discoidal gastropods with wide umbilicus. Protoconch discoidal, with rounded whorls. Mature whorl cross section rounded to subquadrilateral, mature whorls not in contact in some species. Aperture developing a shallow sinus, but no slit.

Stratigraphic range.—Mississippian to Pennsylvanian.

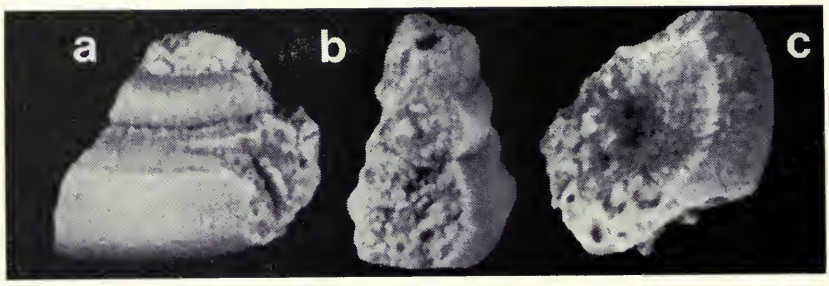


FIG. 24. *Straparollus* (*Straparollus*) sp. indet. **(a)** shoulder view (FMNH UC 25044); **(b)** sectional view, same specimen; **(c)** umbilical view, same specimen. All × 7.

Straparollus (Straparollus) sp. indet. Figure 24.

Description.—Shell small, with gently inclined and flattened upper surface, sharply rounded lateral face, rounded under surface with an angulation at the center and relatively wide and deep umbilicus. Number of volutions unknown. Suture shallow, but well impressed. Earlier whorls apparently rounded. Final whorl embracing the penultimate whorl well below the periphery; section sub-pentagonal; upper surface flattened, inclining downward rather steeply at an angle of about 50 degrees with the horizontal. Angulation occurring at the junction of upper and lateral surfaces, does not develop a carina. Lateral face strongly rounded to the lower angulation at middle of basal surface. Beyond this the base slopes into the umbilicus with gentle inclination of about 25 degrees with the horizontal. Umbilical walls nearly straight; umbilicus seemingly wide and deep. Ornament absent except for fine growth lines, straight from suture to about middle point of upper surface, then beginning to swing gently backward to upper angulation, then straight on the first half of the lateral face, but curving forward on the second half, and continues to do so on the inner basal surface and umbilical walls. Shell moderately thick.

Remarks.—This species is very similar to *Straparollus* (*Straparollus*) *subumbilicatus* Worthen, 1890 (p. 142, pl. 24, figs. 3–3b), from

the Chester Group of Illinois. It fits the description of this species, except that Worthen did not mention the basal angulation, although he noticed the sharply pointed nature of the underside of his species. In view of this uncertainty as well as the doubt concerning the maturity and the incompleteness of our specimen, it is inappropriate either to assign this specimen to *S.* (*S.*) *subumbilicatus* or to give it another name.

Measurement.—FMNH UC 25044: height—5.0 mm.

Material, stratigraphic position, and locality.—One rather immature fragmental specimen FMNH UC 25044, Lower Okaw (Marigold Oolite), Locality 14.

Suborder Pleurotomariina Cox and Knight, 1960

Superfamily Pleurotomariacea Swainson, 1840

Discussion.—Pleurotomariacea shares with Bellerophontacea a similar exhalant emargination. This superfamily retains primitive characters, such as paired ctenidia and other organs. The main difference from Bellerophontacea is its asymmetrically coiled shell with inner nacreous layers.

The single most important feature of this group is the anal emargination with its various associated features, such as sinus, slit, notch, selenizone, and its margins. The anal emargination is considered to be important, as it reflects the nature of such anatomical features as the anal and ctenidial complexes when the organism was alive.

The position of selenizone on the whorl together with umbilical characters, basal features, shell shape, and shell layers are considered as bases in distinguishing families. Also in discriminating genera, more weight is given to the nature of selenizone and associated characters rather than height, width, or ornament in some genera. However, gross character, including those features and nature of parietal surface and columella, are usually taken into consideration. On the specific level, details of ornament, general shape, and basal characters are most likely to be significant.

Family Raphistomatidae Koken, 1896

Subfamily Liospirinae Knight, 1956

Genus **Trepospira** Ulrich and Scofield, 1897

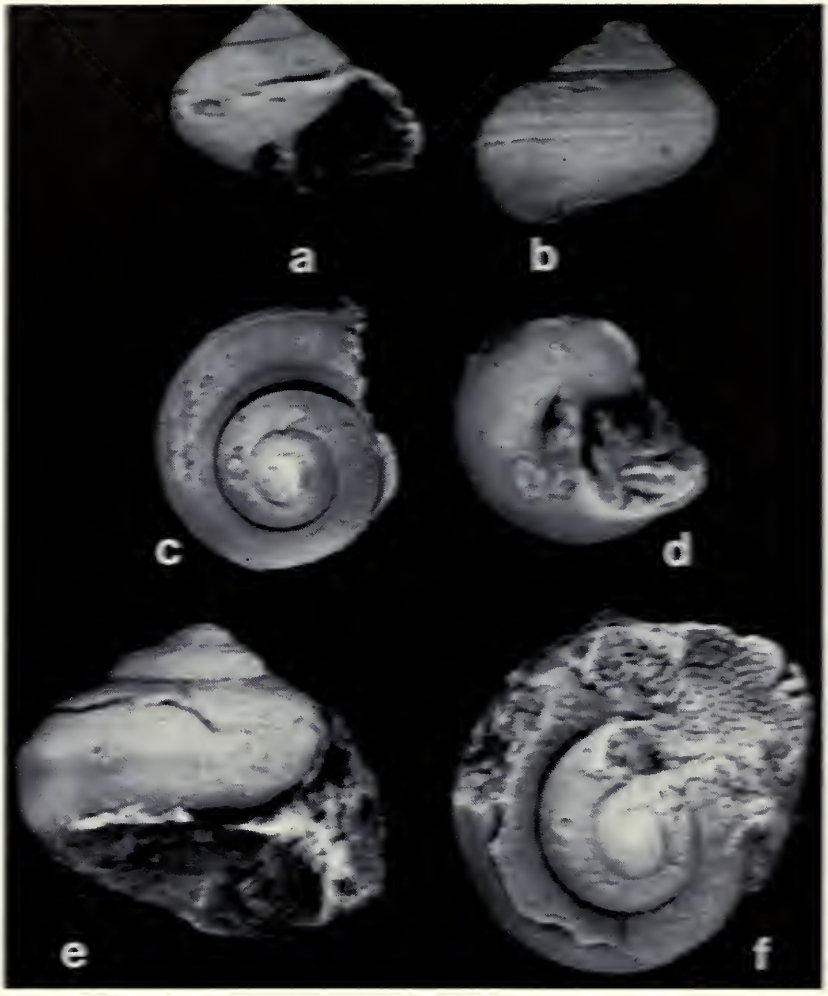


FIG. 25. *Trepospira* (*Trepospira*) *chesterensis* n. sp. (**a**) apertural view of holotype (56291); (**b**) dorsal view, same specimen; (**c**) apical view showing traces of a series of minute nodes near the upper suture, same specimen; (**d**) umbilical view showing cryptomphalous umbilicus, same specimen; (**e**) apertural view (31706); (**f**) apical view, same specimen. All FMNH UC. All × 7.

Type species.—*Pleurotomaria sphaerulata* Conrad, 1842.

Definition.—Shell ornamented with a row of nodes just below the upper suture.

Stratigraphic range.—Devonian to Middle Permian.

Subgenus **Trepospira** Ulrich and Scofield, 1897

Type species.—*Pleurotomaria sphaerulata* Conrad, 1842.

Definition.—Subsutural nodes rounded, base with or without narrow umbilicus.

Stratigraphic range.—Devonian to Middle Permian.

American Mississippian species.—*T.* (*Trepospira*) *chesterensis*, n. sp., reported in this paper, seems to be the first Mississippian species reported from the United States.

Trepospira (Trepospira) chesterensis new species. Figure 25.

Description.—Shell lenticular, height slightly less than diameter, cryptomphalous. About three initial whorls form a rather sharp and low cone, final whorl lenticular. Upper surface, at maturity almost horizontal near the upper suture where a revolving cord bears traces of a series of minute nodes. A shallow groove occurs outside of it from which the surface slopes convexly toward the periphery. Growth lines extremely faint, but probably swing strongly forward from upper suture, and strongly backward again to the periphery. Selenizone a little above periphery, very slightly concave to flatly elevated, bearing slightly curved lunulae. The lower surface below selenizone curved convexly toward base and into the umbilical region. Lower surface smooth except for growth lines curving forward strongly for a short distance and then swinging strongly backward. Aperture unknown.

Comparisons.—This species differs from other Carboniferous species described here by lacking conspicuous nodes and thus resembles *T.* (*Trepospira*) *rotalia* (Hall 1861) (see Hall, 1876, pl. 19, figs. 20–24), a Devonian species from the eastern U.S.A., but the latter has much lower spire and whorls. *T.* (*T.*) *chesterensis* might be ancestral to the Pennsylvanian species which have well-developed nodes.

Measurements (in mm.).—Holotype: FMNH UC 56291, height—3.6; width—4.88; pleural angle—83 degrees.

Material, stratigraphic positions, and localities.—One fairly good and three more or less fragmentary specimens from two localities. Holotype: FMNH UC 56291; other specimens FMNH UC 56292; FMNH UC 31706, Lower Golconda, Locality 13. FMNH UC 30237, Golconda Limestone, Locality 18.

Subgenus **Angyomphalus** Cossman, 1916

Type species.—*Euomphalus radians* deKoninck, 1843.

Definition.—Subsutural nodes lengthened radially; umbilicus partly open, surrounded by narrow circumbilical funicle (Knight et al., 1960, p. 201).

Stratigraphic range.—Mississippian.

American Mississippian species.—Four species are referred:

T. (*Angyomphalus*) ? *excavatus* (Easton, 1962, pp. 99–100, pl. 13, fig. 6), from the Upper Mississippian of Central Montana.

T. (*Angyomphalus*?) sp. (Yochelson and Dutro, 1960, p. 136, pl. 12, figs. 35, 36), from the Lower Mississippian undifferentiated of Northern Alaska.

Mourlonia ? *stellaeformis* Hyde, 1953, (pp. 325–326, pl. 46, figs. 1–4), from the Waverly Series (Logan Formation) of Ohio.

Trepospira (*Angyomphalus* ?) *discus* (Girty, 1910) from the base of the Fayetteville Shale, Arkansas (Yochelson, 1969b, pp. 28–29, pl. 5, figs. 24, 31, 33).

Trepospira (Angyomphalus) kentuckiensis new species. Figure 26.

Description.—Very low spired, final whorl lenticular. Upper whorl face slopes gently toward the periphery; lower face more convex curving sharply into umbilical region; umbilicus unknown. Upper surface just below the suture decorated by thin radiating nodes which are slightly sigmoidal and correspond to growth lines. The growth lines extend beyond the nodes very faintly, swinging backward to selenizone. Selenizone, just above periphery, slightly raised, flat and bordered by two very thin revolving lirae. Growth lines below selenizone, faint, swinging forward for a short distance and then backward in a sigmoid and curve to umbilicus. Suture, well-impressed, situating below selenizone on penultimate whorl. Aperture unknown.

Comparison.—This species differes from *T.* (*A.*) *radians* (deKoninck, 1843) which was redescribed by Knight, 1941 (pp. 36–37, pl. 31, figs. 3a–d), from the Lower Carboniferous of Belgium, by having a higher spire and prominent selenizone exposed on spire.

Measurements (in mm.).—FMNH UC 30720: height—6.2; width —8.4; pleural angle—93 degrees.

Material, stratigraphic position, and locality.—A single specimen FMNH UC 30720, Paint Creek, Locality 19.

FIG. 26. *Trepospira (Angyomphalus) kentuckiensis* n. sp. **(a)** apertural view of holotype (FMNH UC 30720); **(b)** anterior dorsal view, same specimen; **(c)** apical view, same specimen. All × 5.

Subfamily Omospirinae Wenz, 1938

Genus **Baylea** deKoninck, 1883

Type species.—*Trochus yvanii* Léveillé, 1835.

Definition.—Subturbiniform to subtrochiform; selenizone on outer edge of sloping ramp, bordered by strong threads; ornaments dominantly spiral, but collabreal threads and nodes present in some species.

Stratigraphic range.—Mississippian to Middle Permian.

American Mississippian species.—Only three species are reported from the United States, which are referred to this genus:

Baylea coheni Yochelson, 1962 (pp. 78–79, pl. 17, figs. 6, 7), Redwall Limestone, Arizona.

Mourlonia minuta S. Weller, 1916 (pp. 253–254, pl. 18, figs. 35, 36), Ste. Genevieve Limestone, Illinois.

Ptychomphalus sinuatus S. Weller, 1916 (pp. 254–255, pl. 18, figs. 29, 33, 34), Ste. Genevieve Limestone, Illinois.

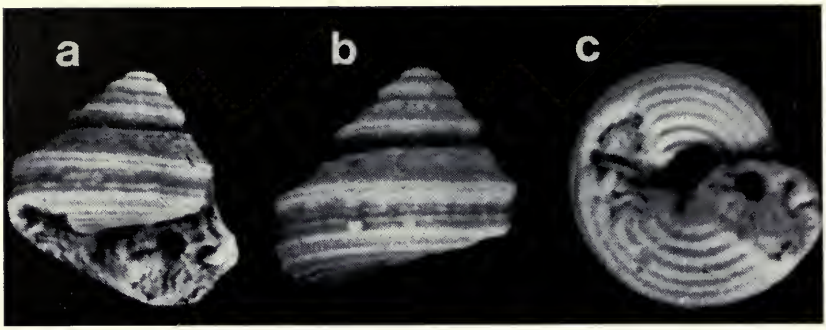


FIG. 27. *Baylea okawensis* n. sp. **(a)** apertural view of holotype (FMNH UC 25040); **(b)** dorsal view, same specimen; **(c)** umbilical view, same specimen. All × 10.

Baylea okawensis, new species. Figure 27.

Description.—Subtrochiform, width and height the same; narrowly phaneromphalous. General whorl profile angular. Upper surface bearing a narrow and nearly horizontal area just beneath upper suture; from this, it slopes down gently but concavely to the angular periphery; upper surface ornamented by seven revolving rounded lirae which decrease in strength downward. Selenizone just above periphery, concave, very narrow, inclined slightly to the upper sloping surface of the whorl, bounded by two relatively strong revolving lirae. Outer whorl face, almost vertical, but slightly slanting inward, quite concave, carrying 4 to 5 revolving lirae, of which the lowest is the strongest and forms the lower angulation. The basal surface convexly curved into the umbilicus; ornamented by about six equal sharply rounded, widely spaced revolving lirae, stronger than those of above. Sutures well-impressed, located at about lower edge of outer face. Growth lines and aperture unknown.

Comparison.—This species closely resembles *Baylea inclinata* (J. M. Weller, 1929b, pp. 15–17, pl. 1, fig. 1, pl. 2, fig. 9, pl. 3, figs. 2–3b, 6), from the Pennsylvanian of western Illinois, but differs by its less numerous lirae, narrower lateral face, and more prominent upper angulation. It differs from three described Mississippian species by having a shorter outer face and less steep upper whorl surface.

Measurements.—FMNH UC 25040: height and width—3.5 mm.; pleural angle—74 degrees.

Material, stratigraphic position, and locality.—A single, fairly well preserved specimen. FMNH UC 25040, Lower Okaw (Marigold Oolite), Locality 14.

Family Eotomariidae Wenz, 1938

Subfamily Eotomariinae Wenz, 1938

Tribe Ptychomphalides Wenz, 1938

Genus **Mourlonia** deKoninck, 1883

Type species.—*Helix carinatus* J. Sowerby, 1812.

Definition.—Turbiniform with gently to rather sharply rounded final whorl; ornament dominantly collabral but sometimes also spiral; growth lines swing strongly backward above periphery and below it except for short distance at top.

Stratigraphic range.—Middle Ordovician to Lower Permian.

American Mississippian species.—The following species are referred to *Mourlonia:*

Mourlonia angulata Easton, 1943 (pp. 150–151, pl. 24, figs. 17–19), Pitkin Formation, Arkansas.

Mourlonia sablei Yochelson and Dutro, 1963 (see: *M. minuta* Yochelson and Dutro, 1960, p. 136, pl. 13, figs. 4, 5), Upper Mississippian, Northern Alaska.

Mourlonia ? reloba Yochelson and Dutro, 1960 (pp. 136–137, pl. 13, figs. 6–9) Upper Mississippian, Northern Alaska.

Ptychomphalus missouriensis S. Weller, 1906 (pp. 455–456, pl. 7, figs. 25, 26), Glen Park Limestone, Missouri.

Mourlonia northviewensis S. Weller, 1899 (p. 41, pl. 5, fig. 13), Northview Sandstone, Northview, Missouri.

Pleurotomaria textiligera Meek, 1871 (pp. 176–177; see also Meek, 1875, pp. 315–316, pl. 13, figs. 7a–b), Waverly Group, Ohio. = *P. mississippiensis* White and Whitfield, 1862.

Mourlonia lativittata (Girty, 1910), Fayetteville Shale, Arkansas (see: Yochelson, 1969b, pp. 29–30, pl. 5, figs. 25, 32, 34).

Mourlonia sp. Sadlick and Nielson, 1963 (p. 1,102, pl. 149, figs. 11–13), Upper Mississippian, Nevada.

Mourlonia angulata Easton, 1943. Figure 28.

Mourlonia angulata Easton, 1943; Jour. Paleontol., **17**, no. 2, pp. 150–151, pl. 24, figs. 17–19.

Description.—Turbiniform, with rather sharply rounded final whorl. Upper whorl face sloping convexly to periphery, ornamented by sharply rounded, collabral lirae swinging rather strongly prosocline and separated by interspaces wider than the lirae. Selenizone

with lower boundary at periphery slightly concave with barely visible curved lunules. Lower surface sloping downward steeply for some distance, then curving sharply upward to form a slightly convex

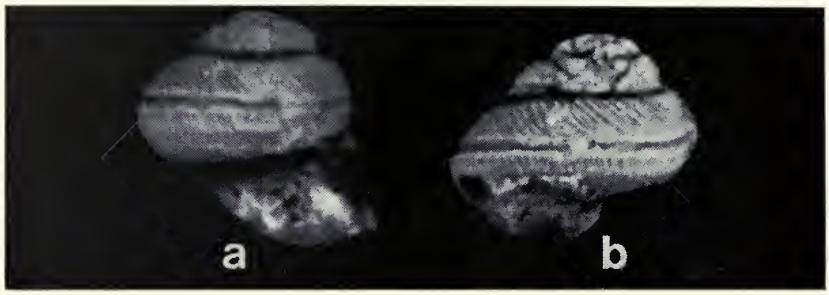


FIG. 28. *Mourlonia angulata* Easton, 1943. **(a)** apertural view (FMNH UC 37478); **(b)** dorsal view, same specimen. All × 10.

base. Transverse lirae on lower surface weaker than those above, at first swinging backward slightly on outer face, then more strongly on bottom. Sutures linear, situated at or below periphery. Aperture unknown.

Measurements (in mm.).—Height—3.0; width—3.2; pleural angle —73 degrees.

Comparison.—This species differs from *Mourlonia minuta* Yochelson and Dutro, 1960, [not S. Weller, 1916] by having a lower spire and narrower selenizone.

Material, stratigraphic position, and locality.—A single specimen FMNH UC 37478, Glen Dean Limestone, Locality 20.

Mourlonia sp. indet. Figure 29.

Description.—Turbiniform, height slightly less than width; with conical spire and broad, sharply rounded final whorl. Upper whorl surface broad, moderately convex, bearing collabral threads which swing backward strongly for a short distance, then straighten over most of the area, and finally curve strongly near the selenizone. A moderately strong revolving lira is located quite close to upper suture, and three or four other extremely faint ones occur on the upper surface. Selenizone at periphery, moderately wide, flat, bordered by thin revolving lirae, and decorated with closely spaced lunulae. Lower whorl surface slightly convex, with growth lines swinging forward for a short distance below selenizone, and then

probably backward on most of the base. Suture shallow, at lower border of selenizone. Seemingly with umbilicus.

Comparison.—This species differs from *Mourlonia angulata* Easton, 1943, by having a wider shell and having weaker ornamentation.

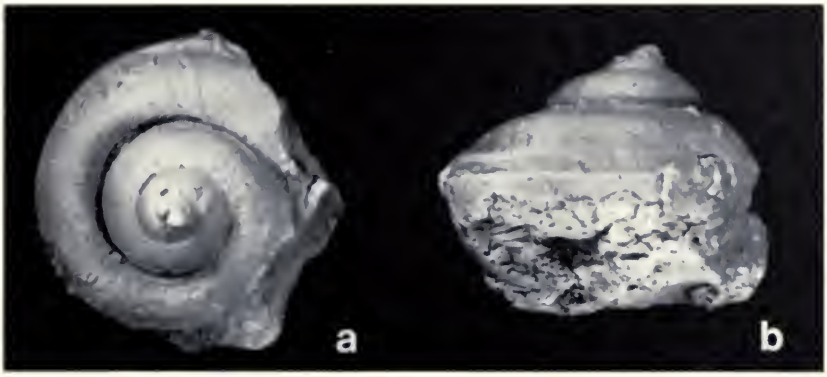


FIG. 29. *Mourlonia* sp. indet. **(a)** apical view (FMNH UC 31705); **(b)** lateral view of spire whorls, same specimen. All × 3.5.

Material, stratigraphic position, and locality.—Three specimens, one nearly perfect, FMNH UC 31705, Lower Golconda Limestone, Locality 13.

Measurements (in mm.).—FMNH UC 31705; width—about 12; width of selenizone—0.9; pleural angle—85 degrees.

Genus **Euconospira** Ulrich *in* Ulrich and Scofield, 1897.

Type species.—*Pleurotomaria turbiniformis* Meek and Worthen, 1861.

Definition.—Trochiform, base moderately convex to slightly concave, pseudo or non-umbilicate; labral sinus shallow, culminating in deep slit which gives rise to a selenizone between pair of carinae; ornament dominantly collabral with lirae increasingly curved backward to selenizone and forward to base.

Stratigraphic range.—Lower Mississippian to Middle Permian.

American Mississippian species.—The following species reported from Mississippian formations of the United States are referred to this genus:

Pleurotomaria conula Hall, 1857 (see 1883, pp. 358–359, pl. 32, fig. 17), Spergen Limestone, Indiana.

Euconospira disjuncta Girty, 1910 (p. 230; see also: Yochelson, 1969b, pp. 30–31, pl. 5, figs. 36, 39, 41, 42) Fayetteville Shale, Arkansas.

Murchisonia elegantula Hall, 1857 (pp. 27–28; *Pleurotomaria elegantula*, Hall, 1883, p. 358, pl. 32, fig. 19), Spergen Hill, Indiana.

Pleurotomaria shumardi Meek and Worthen, 1861 (see 1866a, pp. 260–261, pl. 18, figs. 6a–b), Keokuk Group, Warsaw, Illinois.

Mourlonia solida Hyde, 1953 (pp. 326–327, pl. 46, figs. 6–10), Waverly Formation, Ohio.

Bembexia waterlooensis S. Weller, 1916 (pp. 252–253, pl. 18, figs. 38, 39), Ste. Genevieve Limestone, Illinois.

Euconospira sturgeoni new species. Figure 30.

Description.—Trochiform shells, width and height nearly equal, not umbilicate. Young whorls with rounded profile, becoming subangular in larger ones where upper sloping surface is nearly flat and lower more horizontal surface is gently convex. Upper surface bearing closely and uniformly spaced lirae, probably corresponding to growth lines which curve gently and evenly backward to meet the selenizone at an angle of about 45 degrees. Lirae variously developed at different ontogenetic stages on upper whorls extending uniformly across surface; on larger whorls generally, becoming weaker a short distance below the suture and passing into more ordinary growth lines or disappearing entirely. Selenizone narrow, sloping downward and outward very steeply, bounded by raised angular ridges; surface marked by closely and uniformly spaced deeply crescentic lunulae, deepest slightly above the middle. Lower surface with a concave band, just below and equal in width to the selenizone, margined by a ridge less prominent than those bounding the selenizone. The suture between whorls follows approximately the position of this ridge. Lower surface bearing closely and uniformly spaced lirae, probably corresponding to growth lines. These lirae, somewhat weaker than those on upper surface, follow a double S-shaped curve. They convex forward on the marginal band, reversing at the bounding ridge and continuing as a broad shallow sinus on the outer half of the lower surface and then becoming gently convex again into the umbilical region. These are crossed in several individuals by weak, somewhat more widely spaced, revolving lirae. Aperture and depth of slit unknown.

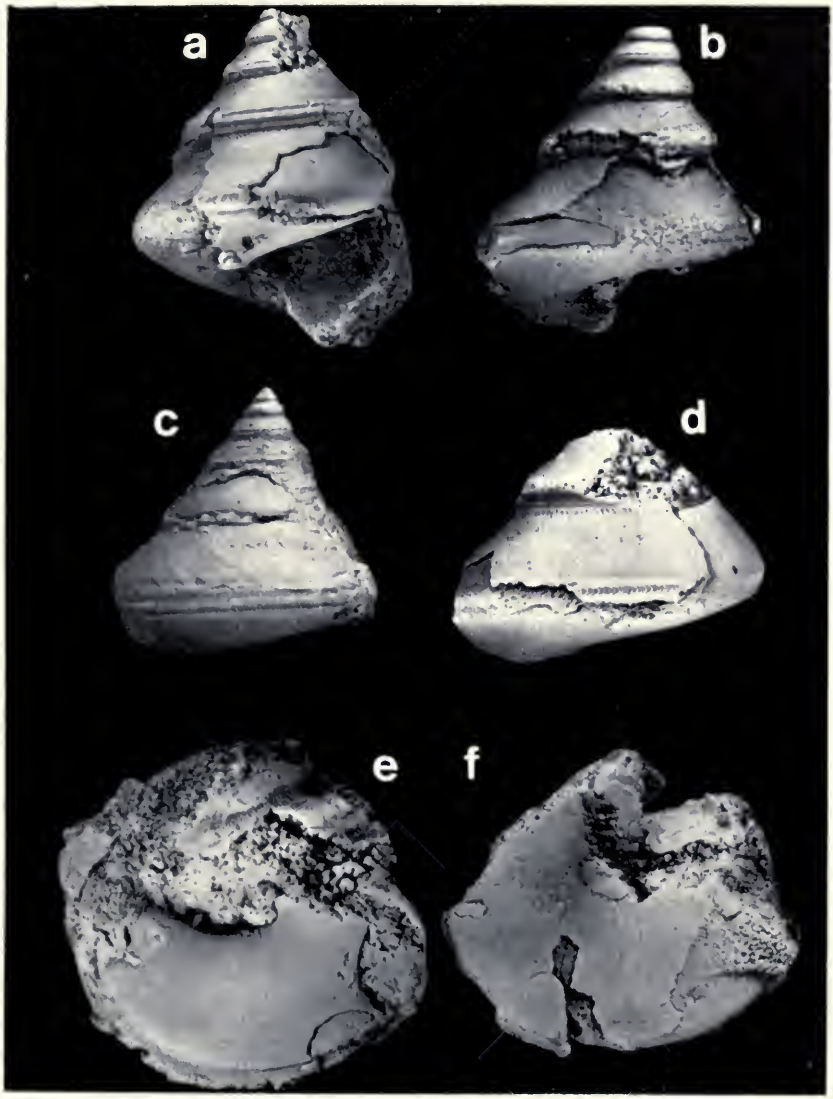


FIG. 30. *Euconospira sturgeoni* n. sp. **(a)** apertural view of holotype (56293); **(b)** dorsal view, same specimen; **(c)** dorsal view showing selenizone and concave band below it (56294-A); **(d)** dorsal view showing concave selenizone with U-shaped lunulae (56294-B); **(e)** umbilical view showing concave band at margin and weak basal ornaments (56294-C); **(f)** umbilical view showing basal ornaments (56294-D). All FMNH UC. All × 3.

Comparison.—This species differs from *Euconospira trochiformis* (Longstaff) and *Euconospira conica* (Phillips) (see Longstaff, 1912, pp. 303–304, pl. 30, figs. 5a–d; Batten, 1966, part 1, p. 33, pl. 4, fig. 1), British Lower Carboniferous forms by lack of a prominent concave ridge above selenizone. It differs from *E. elegantula* (Hall, 1857, pp. 27–28; Hall, 1883, p. 358, pl. 32, fig. 19), from the Spergen Hill of Indiana, by being wider and having a concave ridge beneath selenizone. It differs from *E. turbiniformis* (Meek and Worthen, 1861), from the Pennsylvanian La Salle Formation of Illinois, by having a concave ridge below selenizone and inflated whorls. This species resembles *E. varizona* Batten, 1958 (pp. 232–233, pl. 39, figs. 18–22, pl. 40, figs. 10, 11), except that the ornamentation is much weaker and upper whorl surface much flatter. It differs from *E. conoides* (Meek and Worthen, 1867) (see Meek and Worthen, 1873, pp. 603–604, pl. 28, figs. 1a–c), a Pennsylvanian form from Illinois, by having more impressed sutures.

Measurements.—FMNH UC 56293: diameter—18 mm.; apical angle—65 degrees.

Material, stratigraphic position, and locality.—Nine variously imperfect and fragmentary specimens from a single locality. Holotype FMNH UC 56293; four specimens FMNH UC 56294; four specimens FMNH UC 30340, Glen Dean Limestone, Locality 12.

Euconospira cf. **E. sturgeoni** new species. Figure 31.

Comparison.—This species is smaller than the larger *E. sturgeoni* n. sp. It resembles it closely in most respects except that the transverse lirae are strongly developed and the concave band at the outer margin of the lower whorl surface is not developed. Instead the lower surface slopes steeply downward and inward from the selenizone and then turns into the more horizontal surface without the intervention of a ridge. Perhaps the marginal band and ridge are developed only on the larger whorls of *E. sturgeoni*, and this smaller species is immature in that respect.

Material, stratigraphic position, and locality.—One well preserved specimen FMNH UC 37468, Glen Dean Limestone, Locality 20.

Measurement.—FMNH UC 37468: diameter about 10 mm.

Euconospira sp. indet. 1. Figure 32.

Description.—This species resembles *E.* cf. *E. sturgeoni* except as follows: The pleural angle is more acute. Ornament of the upper

FIG. 31. *Euconospira* cf. *E. sturgeoni* n. sp. **(a)** apertural view, × 5 (FMNH UC 37468); **(b)** umbilical view showing basal ornaments and absence of marginal concave band, × 5.5, same specimen.

whorl surface includes low, rather obscure, revolving lirae and those of the lower surface are more closely spaced and somewhat more prominent. Selenizone is somewhat flattened, below periphery, slanting inward, and bears about four revolving lirae while concave lunulae are not apparent on it.

Measurements (in mm.).—Height—9.5; width—7.9; width of selenizone—0.7; pleural angle—54 degrees; number of volutions—7.5.

Material stratigraphic position, and locality.—One specimen FMNH UC 37466, Golconda Limestone, Locality 21.

FIG. 32. *Euconospira* sp. indet. 1. **(a)** dorsal view (FMNH UC 37466); **(b)** umbilical view, same specimen. All × 5.

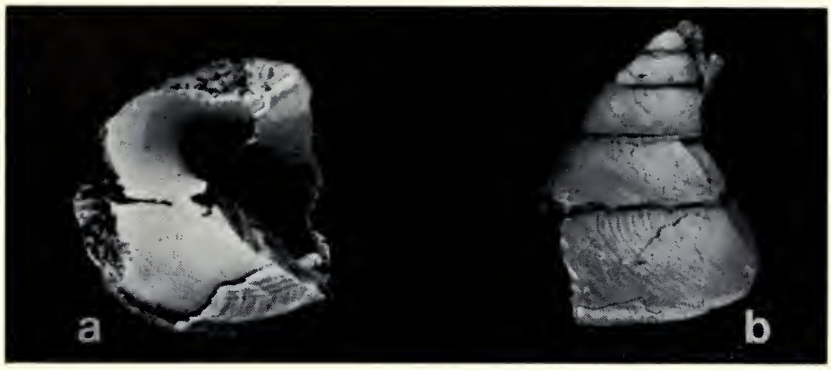


FIG. 33. *Euconospira* sp. indet. 2. **(a)** umbilical view showing slanting selenizone at margin and some part of basal ornament (FMNH UC 30146); **(b)** dorsal view, same specimen. All × 3.5.

Euconospira sp. indet. 2. Figure 33.

Description.—This species resembles *E. sturgeoni* n. sp. except as follows: Growth lines of upper surface are distinct but not raised to produce delicate ridges. Selenizone is below periphery and is directed downward as well as inward. The umbilicus seems to be perforate. Sutures are very shallow and unimpressed.

Comparison.—The shallow sutures of this species suggest *E. disjuncta* Girty, 1910 (p. 230; 1915a, pp. 114–115, pl. 11, fig. 10), from Batesville Sandstone of Northern Arkansas, but its selenizone is below periphery.

Measurements.—FMNH UC 30146: height—13 mm.

Material, stratigraphic position, and locality.—One imperfect specimen FMNH UC 30146, Golconda Limestone, Locality 22.

Euconospira sp. indet. 3. Figure 34.

Description.—This species resembles *E. sturgeoni* n. sp. except as follows: It is very minute, more acute, and surface is so pitted that ornament is barely visible. No trace of revolving lirae on base is seen. Base is also narrowly umbilicate. This species also resembles *E. conula* (Hall, 1857) greatly in size and form, but differs in having an angulation below selenizone of final whorl.

Measurements (in mm.).—Height—5.5; width—4.1; pleural angle —45 degrees.

Material, stratigraphic position, and locality.—One specimen FMNH UC 25047, Lower Okaw (Marigold Oolite), Locality 14.

FIG. 34. *Euconospira* sp. indet. 3. **(a)** apertural view (FMNH UC 25047); **(b)** umbilical view, same specimen. All × 7.

Subfamily Neilsoniinae Knight, 1956

Genus **Neilsonia** Thomas, 1940.

Type species.—*Neilsonia roscobiensis* Thomas, 1940.

Definition.—Conical, whorls sometimes flat, but usually concave immediately below suture, flattening out and becoming concave above the selenizone; selenizone relatively broad, located low on final whorl and just above sutures on spire, bounded on each side by plain raised threads; ornament collabral with tendency toward nodding at upper end.

Stratigraphic range.—Mississippian to Middle Permian.

American Mississippian species:

Murchisonia insculpta Hall, 1857 (p. 26; 1883, pp. 359–360, pl. 32, fig. 18), from Spergen Limestone of Indiana.

Pleurotomaria nodomarginata McChesney, 1860 (McChesney, 1865, pl. 7, figs. 1, 1a–1c), from Batesville, Arkansas.

Murchisonia uninodocarinata Hyde, 1953 (pp. 328–329, pl. 46, figs. 15, 16), from the Waverly Group of Ohio.

Neilsonia sp. Easton, 1942 (p. 86, pl. 11, fig. 5) from Pitkin Limestone of Northern Arkansas.

Neilsonia welleri new species. Figures 35–36.

Description.—Moderately high spired shells, pleural angle generally decreasing in acuteness with maturity. Height about twice as great as diameter. Selenizone located nearly centrally on whorl, concave, bounded by sharp ridges, the lower projecting a little beyond upper one. Upper part of whorl at angle of about 18 degrees

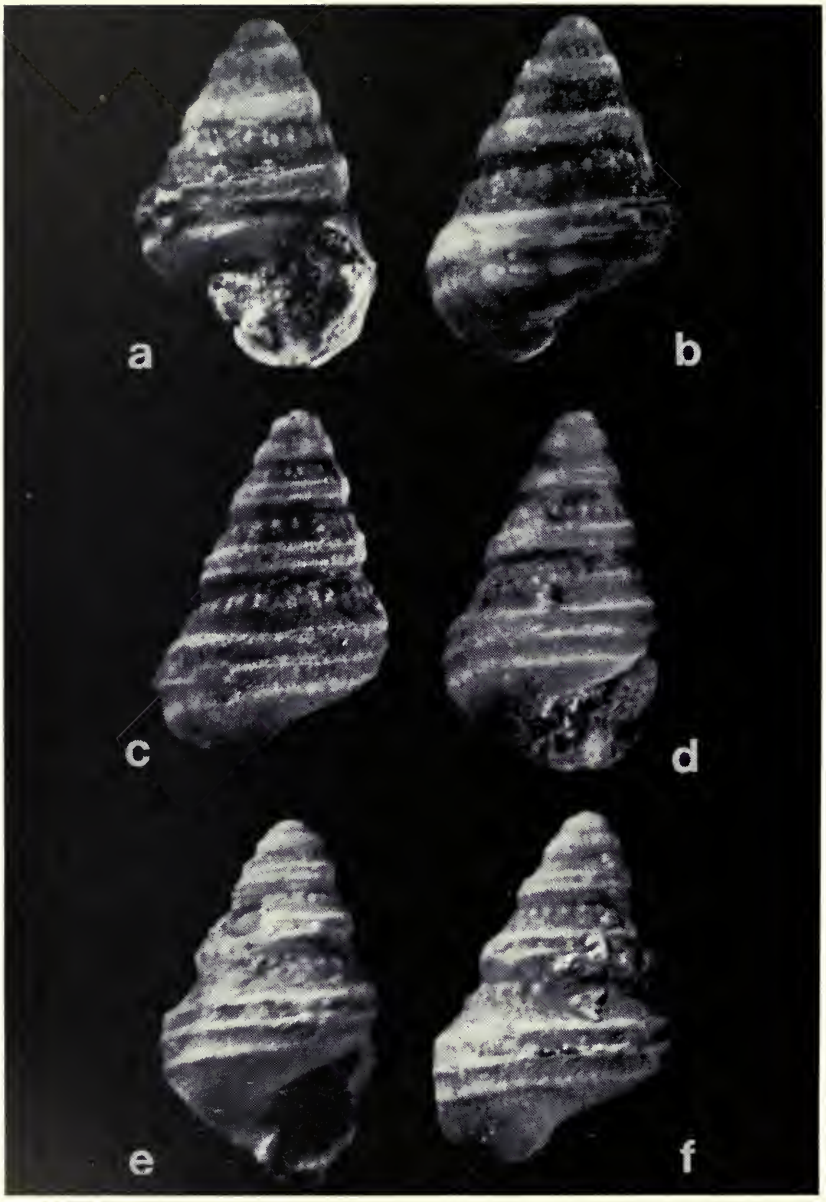


FIG. 35. *Neilsonia welleri* n. sp. **(a)** apertural view (56296–A); **(b)** dorsal view, same specimen; **(c)** dorsal view (56296–B); **(d)** apertural view, same specimen; **(e)** apertural view (56296–C); **(f)** dorsal view, same specimen.

FIG. 35. *Continued.—Neilsonia welleri* n. sp. **(g)** dorsal view of holotype (56295); **(h)** apertural view, same specimen; **(i)** apertural view of a younger specimen (56296-D; **(j)** dorsal view, same specimen. All FMNH UC. All × 12.

from vertical, becoming slightly concave just above selenizone. Some individuals have a gently concave inward sloping band just below selenizone but in others the whorl curves rather evenly into the lower surface. Ornament and growth lines not obvious. Upper whorl surface carries evenly spaced rounded ribs, sloping gently backward from suture, variable in length but continuing almost to selenizone in some individuals. Growth lines below selenizone very weak and direction uncertain. Suture on all whorls, except possibly a few of the earliest ones, located at or slightly below the lower margin of selenizone. Aperture and depth of slit unknown.

Comparisons.—This species is very similar to *Neilsonia insculpta* (Hall, 1857), a Middle Mississippian species from Indiana, but the

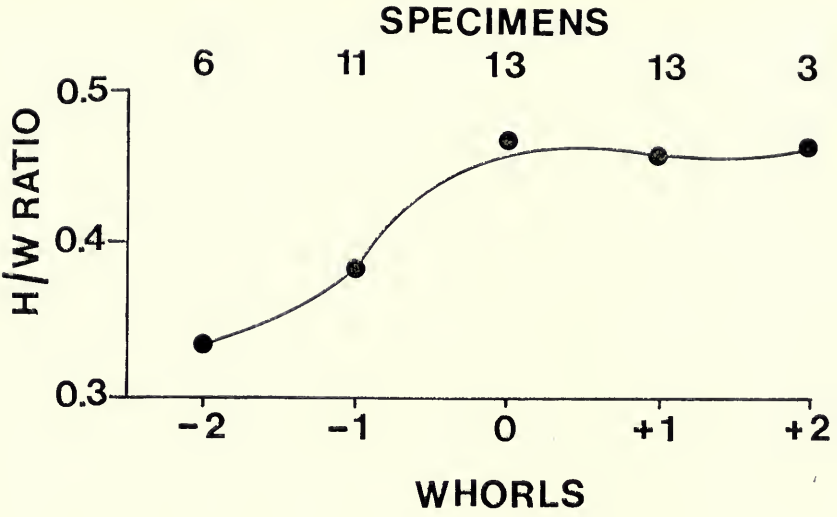


FIG. 36. Curve showing average height and width of whorls in 13 specimens of *Neilsonia welleri* n. sp.

latter has higher whorls and the transverse ribs are stronger. *N. welleri* seems to be intermediate between *N. roscobiensis* Thomas, 1939 (pp. 46–48, pl. 2, figs. 7a–b) and *N. acuminata* Thomas, 1939 (pp. 48–49, pl. 2, figs. 8a, b), both Lower Carboniferous species from Scotland. The former has a lower spire and coarser collabral cords

TABLE 17.—Measurements (in mm.) of *Neilsonia welleri* n. sp.

Specimen FMNH UC	H	W	Ws	Pa	Nw	H/W
56296-B	3.9′	2.4	0.4	37°	5.0+	1.63
56296-C	3.9	2.6	0.3	39°	5.0+	1.50
56296-A	4.0	2.5	0.3	47°	5.5	1.60
56295	3.8	2.3	0.3	37°	5.5	1.65
56296-D	3.4	2.2	0.3	46°	5.5	1.50
25058-1	3.0	2.0	0.2	45°	5.5	1.50
25058-2	2.9	2.0	0.2	45°	4.0+	1.45
25058-3	...	...	0.3	38°	5.5	....
25058-4	3.0	1.9	0.2	37°	5.5	1.58
25058-5	2.7	1.9	0.2	50°	4.0	1.42
25058-6	3.0	2.1	0.2	56°	5.0	1.43
25058-7	2.7	1.9	0.2	47°	4.0+	1.42
25058-8	2.8	2.0	0.2	34°	5.0	1.40
25058-9	3.2	1.9	0.2	46°	5.5	1.79
Total	42.3	27.7	3.5	604	...	19.87
Mean	3.26	2.13	0.25	43.15	...	1.53
S.D.	0.15	0.05				
S.E. (m)	0.04	0.01				

Corr. coeff. between H and W = +0.92

TABLE 18.—Measurements (in mm.) of each whorl of *Neilsonia welleri* n. sp.

Specimen FMNH UC		Whorl No.				
		−2	−1	0	+1	+2
	H	.....	0.300	0.500	0.600	0.900
56296-B	W	.....	0.800	1.030	1.550	2.050
	H/W	.....	0.375	0.487	0.387	0.439
	H	.....	0.300	0.500	0.750	.....
56296-C	W	.....	0.800	1.080	1.600	.....
	H/W	.....	0.375	0.463	0.469	.....
	H	0.100	0.300	0.500	0.700	0.950
56296-A	W	0.400	0.800	0.103	1.500	2.250
	H/W	0.250	0.375	0.487	0.470	0.422
	H	.....	0.300	0.500	0.750	0.900
56295	W	.....	0.800	1.000	1.400	1.900
	H/W	.....	0.375	0.500	0.536	0.500
	H	0.150	0.300	0.500	0.700	.....
56296-D	W	0.500	0.800	1.040	1.500	.....
	H/W	0.300	0.375	0.481	0.467	.....
	H	0.200	0.300	0.500	0.800	.....
25058-1	W	0.500	0.800	1.100	1.750	.....
	H/W	0.400	0.375	0.455	0.457	.....
	H	.....	.....	0.500	0.750	.....
25058-2	W	.....	.....	1.000	1.550	.....
	H/W	.....	.....	0.500	0.500	.....
	H	0.200	0.300	0.500	0.700	.....
25058-4	W	0.600	0.800	1.040	1.600	.....
	H/W	0.333	0.375	0.481	0.438	.....
	H	.....	0.300	0.500	0.800	.....
25058-5	W	.....	0.750	1.050	1.700	.....
	H/W	.....	0.400	0.476	0.471	.....
	H	.....	0.300	0.500	0.800	.....
25058-6	W	.....	0.820	1.100	1.800	.....
	H/W	.....	0.368	0.455	0.444	.....
	H	.....	.....	0.500	0.700	.....
25058-7	W	.....	.....	1.000	1.500	.....
	H/W	.....	.....	0.500	0.470	.....
	H	0.150	0.300	0.500	0.700	.....
25058-8	W	0.400	0.750	1.080	1.600	.....
	H/W	0.375	0.400	0.463	0.438	.....
	H	0.150	0.300	0.500	0.750	.....
25058-9	W	0.500	0.800	1.080	1.700	.....
	H/W	0.300	0.375	0.463	0.441	.....
N	H/W	6	11	13	13	3
Total	H/W	1.958	4.192	6.212	5.988	1.361
Mean	H/W	0.326	0.381	0.477	0.461	0.467

contrasting with much higher spire and weaker ornament of the latter species.

Ontogeny.—The sigmoidal growth curve (fig. 36) for *Neilsonia welleri* n. sp. indicates senility of some specimens.

Measurements.—Measurements are given in Tables 17 and 18.

Material, stratigraphic position, and locality: Fourteen specimens from a single locality. All are very small, but the larger ones seem

to be mature (see ontogenetic growth curve, fig. 36). Holotype: FMNH UC 56295; four specimens FMNH UC 56296; nine specimens FMNH UC 25058, Lower Okaw (Marigold Oolite), Locality 14.

Genus **Wellergyi** new genus.

Type species.—Wellergyi chesterensis n. sp.

Definition.—Subtrochiform, anomphalous, with depressed and approximately vertical selenizone situated at periphery and at, or just above, sutures on spire; ornament, a network of spiral and collabral lirae above selenizone, the former being more prominent below it; columellar lip slightly arcuate and thickened.

Stratigraphic range.—Upper Mississippian to Pennsylvanian.

Remarks.—This genus resembles *Neilsonia* Thomas, 1940 but the ornament includes revolving lirae and the transverse ridges do not form nodes. It differs from *Phymatopleura* Girty, 1939 by narrower outer face and lack of nodes. *Pleurotomaria brazeriana* Girty, 1927 (p. 428, pl. 25, figs. 8–12), an Upper Mississippian form from southeastern Idaho, and *Pleurotomaria subdecussata* Geinitz, 1866 (pp. 10–11, pl. 1, fig. 11) from Pennsylvanian of Nebraska are referred to this genus.

The word *Wellergyi*, in Burmese language, means senior Weller, which, in turn, refers to Stuart Weller.

Wellergyi chesterensis new species. Figures 37–38.

Description.—Shells subtrochiform, anomphalous. Upper whorl surface steeply sloping, nearly flat but may be slightly convex or more rarely slightly concave; bearing 5 to 8 evenly spaced and nearly equally strong rounded revolving lirae that probably increase in number with growth of shell. Lirae are crossed by collabral ribs leaving suture at about a right angle and curving gently prosocline to selenizone, evenly spaced but somewhat unequally strong, generally comparable to the revolving lirae. Selenizone approximately horizontal bounded by ridges more prominent than lirae, marked by very closely spaced concave growth lines. Suture generally at or

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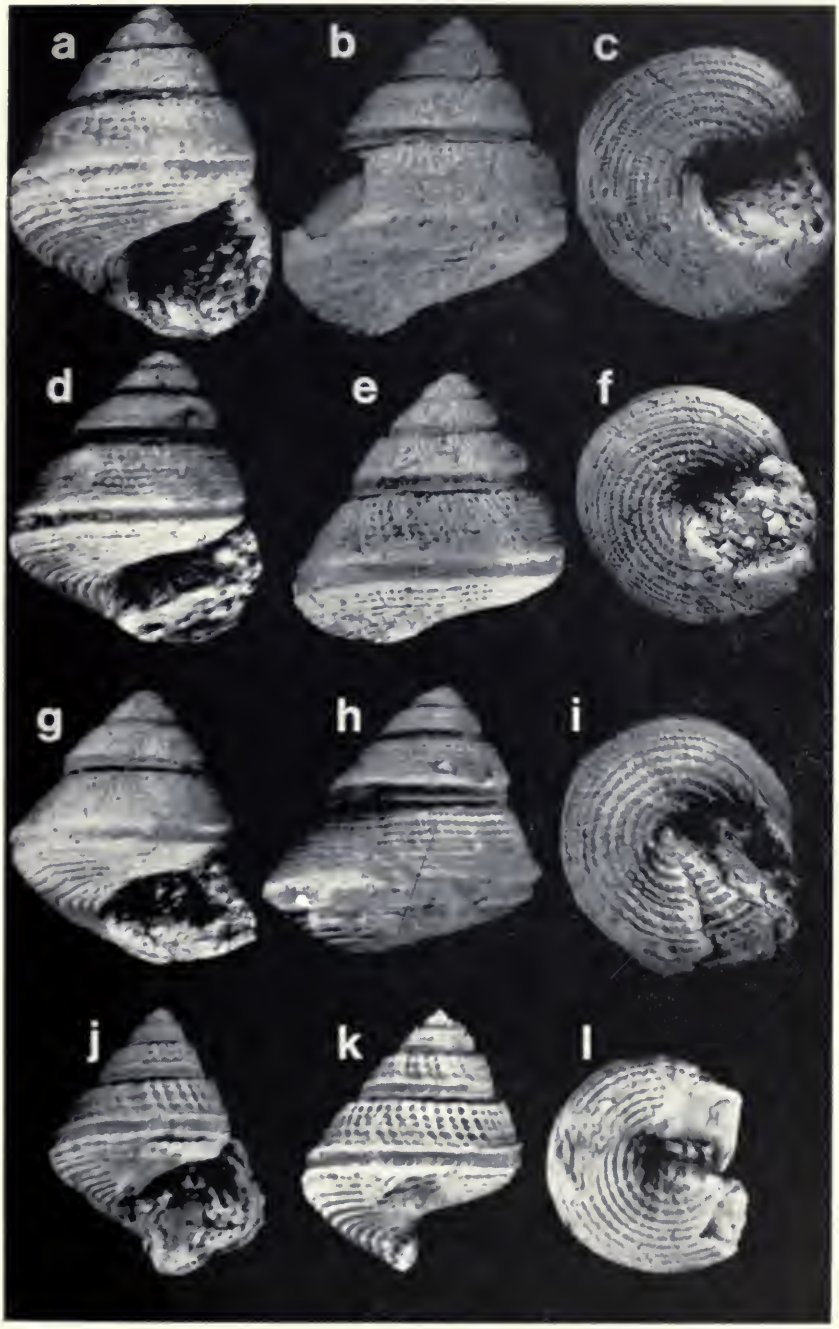
FIG. 37. *Wellergyi chesterensis* n. sp. **(a)** apertural view of holotype, × 5 (56356); **(b)** dorsal view, × 5, same specimen; **(c)** umbilical view, × 5, same specimen; **(d)** apertural view, × 5 (56357-A); **(e)** dorsal view, × 5, same speicmen; **(f)** umbilical view, × 5, same specimen; **(g)** apertural view, × 5 (56357-B); **(h)** dorsal view, × 5, same specimen; **(i)** umbilical view, × 5, same specimen; **(j)** apertural view of rather immature specimen, × 5 (56357-C); **(k)** dorsal view, × 5, same specimen; **(l)** umbilical view, × 5, same specimen.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very slightly below lower boundary of selenizone. Lower whorl surface curving inward rather abruptly from selenizone, moderately convex, bearing about 12 revolving lirae that become stronger and more widely spaced toward umbilical region, crossed by closely spaced, gently sinuous ridges, less prominent than those above selenizone. Aperture and depth of slit poorly known.

Ontogeny.—The average ontogenetic growth curve of the species (see fig. 38) shows that maturity has been attained by some specimens.

Comparison.—This species closely resembles *Wellergyi brazeriana* (Girty, 1927), an Upper Mississippian species from southeastern Idaho, but the latter is a narrower shell and lacks the convex upper whorl shoulder.

Measurements.—Measurements are given in Tables 19 and 20.

TABLE 19.—Measurements (in mm.) of *Wellergyi chesterensis* n. sp.

Specimen FMNH UC	H	W	Ha	Wa	Ws	Pa	H/W
56356	8.7	7.4	3.2	3.8	0.6	59°	1.17
56357-B	7.5	6.7	...	...	0.6	53°	1.12
56357-A	7.5	6.7	3.1	3.6	0.7	58°	1.12
30478-4	7.0	5.7	...	...	0.6	..	1.23
56357-D	8.4	6.8	...	...	0.6	56°	1.24
30478-6	7.1	6.0	...	...	0.5	60°	1.18
56357-G	6.7	5.6	2.5	2.6	0.5	56°	1.19
56357-F	6.7	6.4	...	...	0.6	71°	1.05
56357-H	4.1	3.6	...	...	0.4	61°	1.14
56357-C	5.1	4.3	...	...	0.4	62°	1.15

Material, stratigraphic position, and locality.—Fifteen specimens from a single locality. Holotype: FMNH UC 56356; eight specimens FMNH UC 56357; six specimens FMNH UC 30478, Golconda Limestone, Locality 9.

Family Lophospiridae Wenz, 1938

Subfamily Ruedemanniinae Knight, 1956

Genus **Yochelsonospira** new genus.

Type species.—*Yochelsonospira pagoda* n. sp.

FIG. 37, *Continued.*—*Wellergyi chesterensis* n. sp. **(m)** apertural view, × 5 (56357-D); **(n)** umbilical view, × 5, same specimen; **(o)** oblique apertural view showing selenizone, × 5 (56357-E); **(p)** close-up view, × 8, same specimen; **(q)** apertural view, × 5 (56357-F); **(r)** umbilical view, × 5, same specimen; **(s)** dorsal view, × 5, same specimen; **(t)** dorsal view, × 5 (56357-G); **(u)** dorsal view of immature specimen, × 7 (56357-H). All FMNH UC.

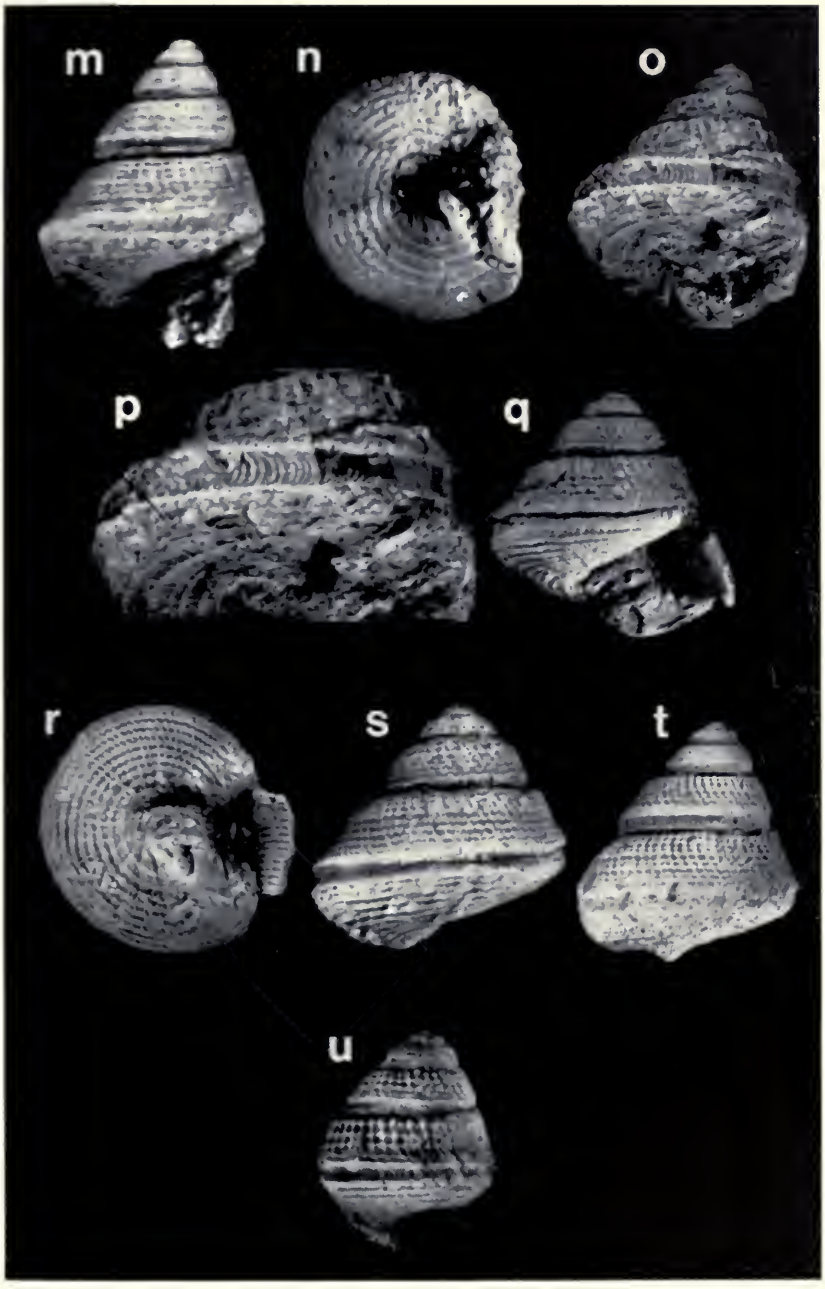
m
n
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TABLE 20.—Measurements (in mm.) of each whorl of *Wellergyi chesterensis* n. sp.

Specimen FMNH UC		Whorl No.					
		−2	−1	0	+1	+2	+3
	H	0.10	0.28	0.50	0.95	1.75	2.70
56356	W	0.40	0.80	1.50	2.50	4.40	6.90
	H/W	0.25	0.35	0.33	0.38	0.40	0.40
	H	....	0.20	0.50	0.98	1.90	2.90
56357-B	W	....	0.85	1.60	2.90	4.90	7.00
	H/W	....	0.24	0.31	0.34	0.39	0.41
	H	....	0.24	0.50	0.90	1.72	2.40
56357-A	W	....	0.80	1.40	2.40	4.00	6.10
	H/W	....	0.30	0.36	0.38	0.43	0.40
	H	....	....	0.50	0.88	1.30	....
	W	....	....	1.55	2.50	3.60	....
	H/W	....	....	0.32	0.35	0.36	....
	H	....	0.26	0.50	0.90	1.55	2.20
56357-D	W	....	0.80	1.35	2.20	3.70	5.50
	H/W	....	0.33	0.37	0.41	0.42	0.40
	H	....	....	0.50	0.95	1.50	....
	W	....	....	1.55	2.65	4.00	....
	H/W	....	....	0.32	0.36	0.38	....
	H	....	0.18	0.50	0.98	1.60	....
56357-G	W	....	0.68	1.38	2.40	3.94	....
	H/W	....	0.26	0.36	0.37	0.41	....
	H	....	0.20	0.50	1.20	1.83	....
56357-F	W	....	0.90	1.80	3.20	5.20	....
	H/W	....	0.22	0.27	0.38	0.35	....
	H	....	0.28	0.50	0.98	1.30	....
56357-H	W	....	0.80	1.48	2.30	3.50	....
	H/W	....	0.35	0.34	0.43	0.42	....
	H	....	0.20	0.50	0.88	1.40	....
56357-C	W	....	0.70	1.20	1.90	3.30	....
	H/W	....	0.28	0.42	0.42	0.42	....
	H	....	0.20	0.50	0.90	1.56	....
30478-1	W	....	0.72	1.40	2.46	4.20	....
	H/W	....	0.28	0.36	0.37	0.37	....
	H	....	0.20	0.50	0.85	1.20	....
30478-2	W	....	0.80	1.40	2.30	3.40	....
	H/W	....	0.25	0.36	0.37	0.35	....
N	H/W	1	10	12	12	12	4
Total	H/W	0.25	2.86	4.12	4.56	4.69	1.61
Mean	H/W	0.25	0.29	0.34	0.38	0.39	0.40

Definition.—Subtrochiform, with convex and highly decorated selenizone at median periphery; narrowly phaneromphalous. Growth lines prosocline above selenizone, sigmoidal on base. Ornamented by spiral and collabral lirae on uppermost surface.

Stratigraphic range.—Upper Mississippian.

Comparison.—This genus differs from *Worthenia* deKoninck, 1883, by being more conical and by lacking a lower angulation on the outer face.

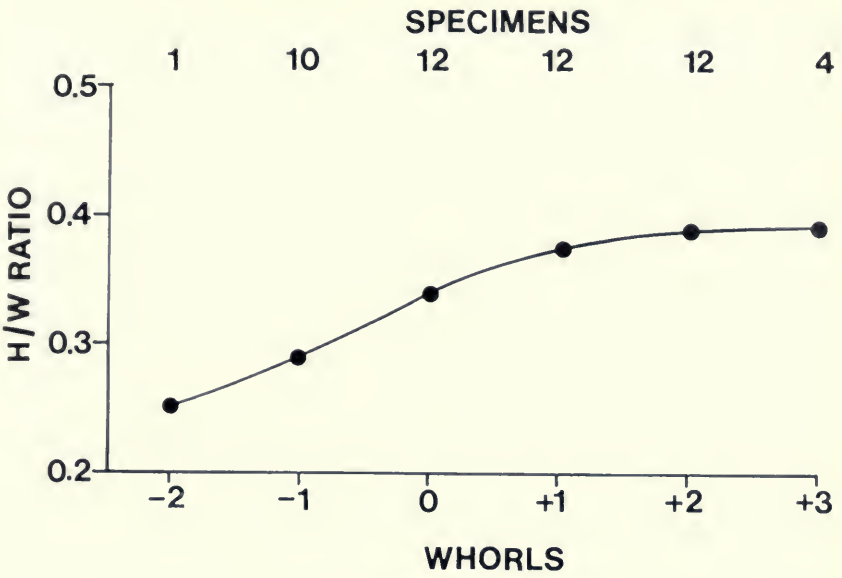


FIG. 38. Curve showing average height to width ratio of 12 specimens of *Wellergyi chesterensis* n. sp.

Yochelsonospira pagoda new species. Figure 39.

Description.—Shell subtrochiform, narrowly umbilicate, height a bit greater than diameter. Upper surface generally nearly flat, but in detail, sloping down steeply and convexly for a short distance below upper suture, and then continuing less steeply to periphery. Ornamented by about 15 rounded and uniformly spaced revolving lirae crossed by equally strong, uniformly spaced collabral lirae that swing backward moderately for a short distance and then more strongly, at an angle about 45 degrees from vertical. Selenizone at periphery convex and narrow, bounded by lirae, stronger than others, bearing thick, curved lunulae, and two inconspicuous median revolving lirae. Surface below selenizone slopes down steeply for a considerable distance, then curves inward to form a narrow convex base. Its revolving lirae are more numerous but fainter than those above. Faint collabral lirae elongated S-shaped with the upper arm shorter than the lower. Suture impressed, locating just below periphery. Aperture seemingly circular, columellar lip thickened and probably curved. Outer lip unknown.

Measurements.—FMNH UC 25315: width—14 mm.; pleural angle—70 degrees.

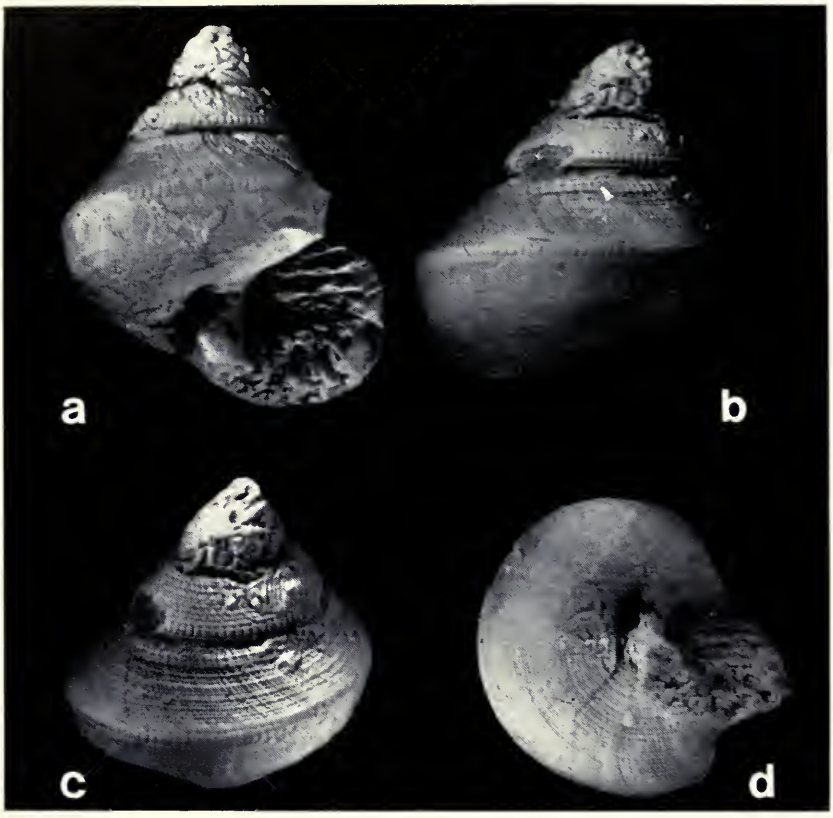


FIG. 39. *Yochelsonospira pagoda* n. sp. **(a)** apertural view of holotype (FMNH UC 25315); **(b)** dorsal view, same specimen; **(c)** oblique dorsal view showing ornamentation on the whorl face and selenizone, same specimen; **(d)** umbilical view showing narrow umbilicus and numerous but weak ornaments, same specimen. All × 3.

Material, stratigraphic position, and locality.—A single specimen FMNH UC 25315, Lower Okaw Limestone, Locality 2.

Family Gosseletinidae Wenz, 1938

Subfamily Gosseletininae Wenz, 1938

Genus **Gosseletina** Fischer, 1885.

Type species.—*Pleurotomaria callosa* deKoninck, 1843.

Definition.—Turbiniform with short slit, narrow flat selenizone high on whorl face; inner lip thickened, nonumbilicate to narrowly umbilicate; surface glossy, may bear spiral and collabral ornaments.

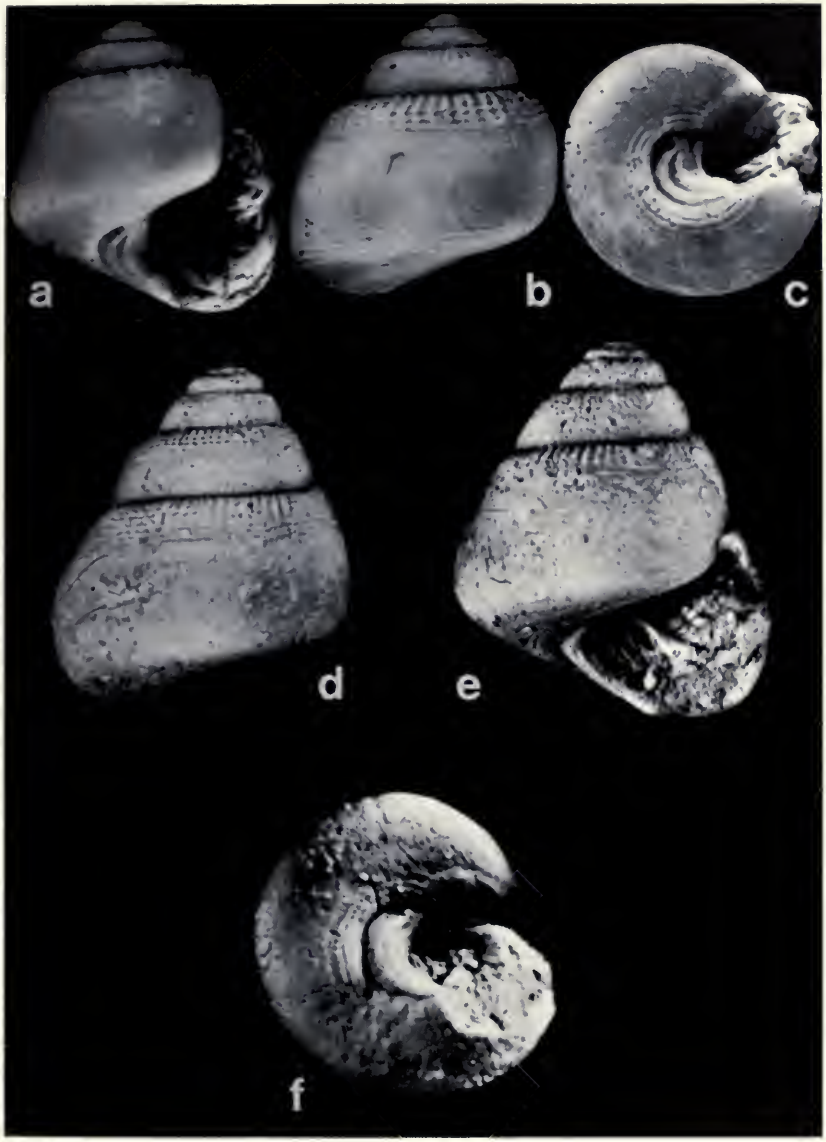


FIG. 40. *Gosseletina johnsoni* n. sp. **(a)** apertural view (30477-1); **(b)** dorsal view, same specimen; **(c)** umbilical view, same specimen; **(d)** dorsal view of holotype (56297); **(e)** apertural view, same specimen; **(f)** umbilical view, same specimen. All FMNH UC. All × 5.

Stratigraphic range.—Lower Mississippian to Permian, ? Triassic.

American Mississippian species.—The following three species are referred to this genus:

Pleurotomaria aspeniana Girty, 1927 (pp. 427–428, pl. 25, figs. 1–7), Brazer Limestone, Southeastern Idaho.

Pleurotomaria subglobosa (Hall, 1857) (see Hall, 1883, p. 355, pl. 32, fig. 10), Spergen Limestone, Indiana.

Gosseletina ? sp. Easton, 1942 (p. 108, pl. 10, figs. 12–14), Pitkin Limestone, Northern Arkansas.

Gosseletina johnsoni new species. Figure 40.

Description.—Height a little greater than diameter, whorls rounded, anomphalous. Young whorls almost evenly rounded, older ones with decreasing curvature below suture and then more abruptly turned-in to lower gently convex surface, producing a progressively steepening conical profile with slightly depressed sutures. Selenizone situated well above middle of whorl, rather indistinct, with gently concave growth lines. Surface above it bearing evenly spaced coastae which curve gently prosocline to selenizone and are crossed by about six uniformly spaced revolving lirae. Shell below selenizone marked by abundant revolving lirae, very faint on outer surface, becoming stronger on lower surface. Growth lines below selenizone evenly convex on outer surface and then reverse to concave curvature on lower surface. Suture gradually moves downward as whorls increase in size until in larger individuals it occurs a little below lower edge of selenizone but still above center of outer whorl surface. Aperture and depth of slit not known.

Comparisons.—This species differs from *G. spironema* (Meek and Worthen, 1867, pp. 272–273; 1873, pp. 601–602, pl. 28, fig. 5), a Pennsylvanian form from Illinois, in having a less rounded final whorl and much weaker ornamentation. It differs from *G. callosa* (de-Koninck, 1843) (see Knight, 1941, p. 138, pl. 27, figs. 2a–c; Batten, 1966, pp. 40–41) from Belgium, by having a less rounded final whorl and more conspicuous ornamentation. It differs from *G. nodosa*

TABLE 21.—Measurements (in mm.) of *Gosseletina johnsoni* n. sp.

Specimen FMNH UC	H	W	Hf	Hs	Ha	Wa	Ws	Pa	Nw
25105-1	7.7	6.8	5.9	1.8	5.0	3.1	0.6	78°	5
56297	10.0	8.1	7.2	2.8	4.9	4.0	0.7	59°	6
30477-1	5.1	4.4	3.8	1.3	...	...	0.4	77°	5
25051-1	2.8	2.7	2.0	0.8	2.5	1.5	...	90°	4

TABLE 22.—Ratios of *Gosseletina johnsoni* n. sp.

Specimen FMNH UC	H/W	H/Hf	Ha/Wa
25105-1	1.13	1.31	1.61
56297	1.23	2.38	1.23
30477-1	1.16	1.34	....
25051-1	1.04	1.40	1.78

Batten, 1966 (pp. 41–42, pl. 4, figs. 15–20, 24), a Lower Carboniferous form from England in having a much higher spire. It also differs from *Gosseletina* sp. Easton, 1942 (pl. 10, figs. 13, 14) by having more rounded whorls.

Measurements.—Measurements and ratios of measurements are given in Tables 21 and 22.

Material, stratigraphic positions, and localities.—Twenty-three specimens from four localities. Holotype: FMNH UC 56297, three specimens FMNH UC 25936, Lower Okaw Limestone, Locality 23; one specimen FMNH UC 56298 and five specimens FMNH 30477, Golconda Limestone, Locality 9; eight specimens FMNH UC 25051, Lower Okaw Limestone (Marigold Oolite), Locality 14; five specimens FMNH UC 25105, Lower Okaw (Evansville Oolite), Locality 3.

Family Porcelliidae Broili, 1924

Genus **Porcellia** Léveillé, 1835.

Type species.—*Porcellia puzo* Léveillé, 1835.

Definition.—With the characters of the family; pseudo-isotrophic coiling with dextral protoconch; selenizone at periphery, very narrow and groove-like.

Stratigraphic range.—Devonian to Pennsylvanian, ? Permian.

American Carboniferous species.—*Porcellia chesterensis* n. sp. seems to be the first species ever reported from the American Upper Mississippian. Five species, viz., *P. crassinoda* White and Whitfield, 1862 (see S. Weller, 1900, p. 116, pl. 5, figs. 1, 2); *P. nodosa* Hall, 1860 (see Meek and Worthen, 1868, pp. 458–459, pl. 14, figs. 1a, b); *P. obliquinoda* White, 1862 (see S. Weller, 1900, pp. 116–117, pl. 5, fig. 3); *P. rectinoda* Winchell, 1863 (see S. Weller, 1899, pp. 43–44, pl. 5, fig. 7) and *P. ornatissimua* (A. K. Miller et al., 1949, p. 604, pl. 97, figs. 1–3) are figured and reported from the Lower Mississippian. *P. peoriensis* Worthen, 1884 (see Worthen, 1890, pp. 138–139, pl. 23, figs. 4a–b; Sturgeon, 1964 b, pp. 743–744, pl. 122, figs. 1–3) seems to be the only figured species from the Pennsylvanian.

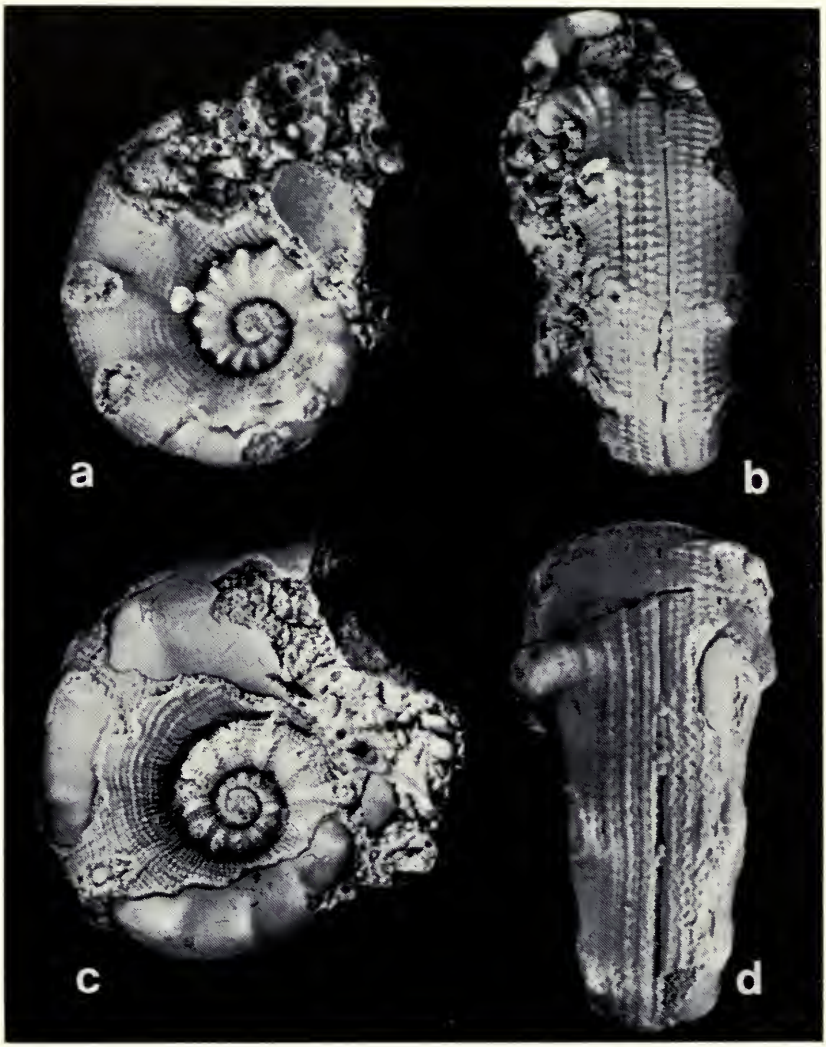


FIG. 41. *Porcellia chesterensis* n. sp. **(a)** right lateral view of holotype (37467); **(b)** dorsal view, same specimen; **(c)** right lateral view showing a laterally directed node, others broken away (56299); **(d)** dorsal view (37467). All FMNH UC. All × 3.5.

Porcellia chesterensis new species. Figure 41.

Description.—Shell gradually enlarging, coiled nearly in a plane with wide shallow umbilici on both sides. Young part of shell with a low spire but at an early stage coiling becomes essentially symmetrical. Whorl subtrapozoidal in cross-section, outer surface flat to

slightly convex, lateral converging surface gently convex. Laterally directed nodes becoming conspicuous at an early stage, about 12 to a whorl, at first appear as broadly rounded transverse ribs but with growth the outer part becomes progressively more prominent. Selenizone a very narrow angular groove centrally located on the outer whorl surface. Ornament of revolving lirae most prominent on outer surface, crossed by weak transverse threads that rise as small nodes where they intersect the lirae. Ornament continues on the sides of the large laterally directed nodes but on the last whorl does not extend across their smooth and polished summits.

Comparisons.—This species differs from *P. puzo* Léveillé, 1835 (see Knight, 1941, p. 268, pl. 38, figs. 6a–e) by having a less convex outer whorl face. It differs from *P. nodosa* Hall, 1860, in being smaller and probably having coarser revolving and collabral lirae. It also differs from *P. ornatissimua* (A. K. Miller et al., 1949), by having less rounded whorls and less pronounced growth lines.

Measurements.—Measurements are given in Table 23.

TABLE 23.—Measurements (in mm.) of *Porcellia chesterensis* n. sp.

Specimen FMNH UC	L	W
37467	17.7	6.8
56300	14.2	6.3
56299	19.1	8.0
25943	22.3	9.0
11388-1	11.1	4.9

Material, stratigraphic positions, and localities.—Thirteen specimens, all more or less imperfect from five localities. Holotype FMNH UC 37467, one specimen FMNH UC 56299 and one specimen FMNH UC 56300, Paint Creek Limestone, Locality 24; three specimens FMNH UC 30344, Glen Dean Limestone, Locality 12; three specimens FMNH UC 25174, Lower Okaw (Marigold Oolite), Locality 14; three specimens FMNH UC 11388, Chester, Locality 25; one specimen FMNH UC 25943, Lower Okaw Limestone, Locality 23.

Family Phymatopleuridae Batten, 1956

Genus **Glyptotomaria** Knight, 1945

Type species.—*Glyptotomaria apiarium* Knight, 1945.

Definition.—Shape highly variable, turbiniform to discoidal, commonly with flattened and non-umbilicate base; ornamented with sharp collabral and spiral lirae; the former swinging backward above

selenizone but are straight below it and with a broad sinus on the base; selenizone depressed, bordered by cords, bears sharp regularly spaced lunulae; shallow sinus at upper end of columellar lip.

Stratigraphic range.—Mississippian to Middle Permian.

Subgenus **Dictyotomaria** Knight, 1945

Type species.—*Pleurotomaria scitula* Meek and Worthen, 1861.

Definition.—Turbiniform with moderately deep sutures and somewhat flat base.

Stratigraphic range.—Mississippian to Pennsylvanian.

American Mississippian species.—The following species reported from the Mississippian formations of the United States are referred to this subgenus:

Phanerotrema brazerianum Girty, 1927 (p. 430, pl. 25, figs. 25–27), Brazer Limestone, Southeastern Idaho.

Phymatopleura brazerianum var. *springerensis* Elias, 1958 (pp. 9, 11, pl. 2, fig. 7), Late Mississippian, Southern Oklahoma.

Pleurotomaria meekana Hall, 1857 (p. 22; 1883, pp. 353–354, pl. 32, figs. 8, 9), St. Louis Limestone, Indiana.

Ptychomphalus depressus S. Weller, 1916 (p. 255, pl. 18, fig. 30), Ste. Genevieve Limestone, Southwestern Illinois.

Ptychomphalus wortheni S. Weller, 1916 (pp. 253–254, pl. 18, figs. 24–28), Ste. Genevieve Limestone, Southwestern Illinois.

Glyptotomaria (Dictyotomaria) yochelsoni new species. Figure 42.

Description.—Shell somewhat turreted, seemingly with perforate columella. Upper whorl surface slightly convex, sloping down from suture and curving sharply at shoulder into outer surface. Reticulate ornament produced from crossing of two spiral lirae by evenly spaced transverse lirae directed slightly forward from suture and then curving gently to shoulder which they reach at approximately a right angle; intersections of lirae not elevated in nodes. Outer whorl face sloping steeply downward and outward, bounded by revolving lirae. Selenizone located near middle between revolving lirae and about half as wide as outer face; ornamented with thread-like lunulae. Lower whorl surface not abruptly set off from outer face, gently convex, bearing seven or more revolving lirae somewhat weaker than those on upper surface of whorl. Aperture unknown.

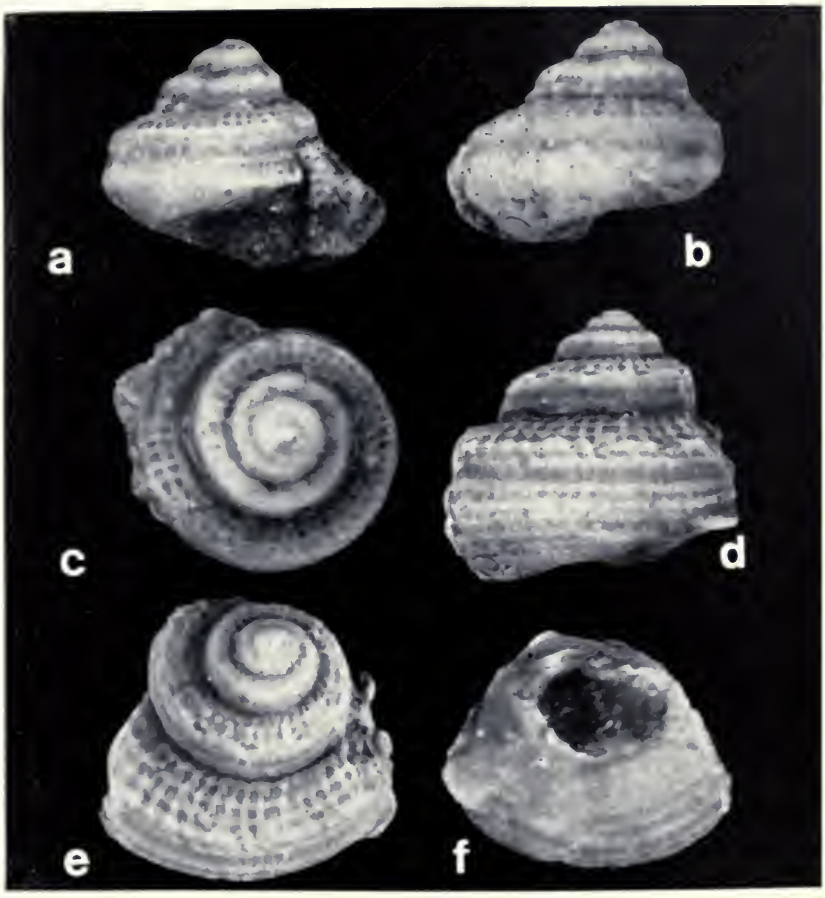


FIG. 42. *Glyptotomaria (Dictyotomaria) yochelsoni* n. sp. **(a)** apertural view of holotype (25037); **(b)** dorsal view, same specimen; **(c)** apical view, same specimen; **(d)** dorsal view (25104); **(e)** oblique apical view, same specimen; **(f)** umbilical view, same specimen. All FMNH UC. All × 10.

Comparison.—This species differs from *G. (D.) wortheni* (S. Weller, 1916) by having weaker revolving lirae, a less steeply sloping upper whorl face, and slightly inwardly slanting outer face.

Measurements (in mm.)—Measurements on the holotype are: height—3.0; width—3.6; pleural angle—84 degrees.

Materials, stratigraphic positions, and localities: Three specimens from two localities. Holotype: FMNH UC 25037, Lower Okaw

(Marigold Oolite), Locality 14; FMNH UC 56301 and FMNH UC 25104, Lower Okaw (Evansville Oolite), Locality 3.

Genus **Borestus** Thomas, 1939

Type species.—*Borestus wrighti* Thomas, 1939.

Definition.—Shell gradate, turbiniform with an almost vertical outer whorl face, with selenizone situated at its center; ornament consisting of sharp transverse threads.

Stratigraphic range.—Upper Mississippian to Middle Permian.

American Mississippian species.—*Borestus chesterensis* (Meek and Worthen, 1861, p. 460; 1866b, pp. 303–304, pl. 24, figs. 1a–c) seems to be the only figured species from the Mississippian.

Borestus chesterensis (Meek and Worthen, 1861). Figure 43.

Pleurotomaria chesterensis. Meek and Worthen, 1861, Proc. Acad. Nat. Sci., Phil., p. 460; Meek and Worthen, 1866a, Geol. Surv. Ill., vol. 2, pp. 303–304, pl. 24, figs. 1a–c.

Discussion.—The specimens are too poor for complete description. Largest specimen estimated to have been about 23 mm. in diameter and perhaps 25 mm. or more high, is somewhat larger than the individual illustrated by Meek and Worthen. The individuals are turreted and present a profile similar to the original illustration. The upper whorl surface is flat, slopes outward and downward, and turns rather abruptly into the near vertical flattened outer face. This terminates below at a sharp angulation and the flat lower surface slopes, less steeply than the upper one, into the umbilical region. The mold reveals ornament in considerable detail. The selenizone occupies slightly more than one-fourth of the outer whorl face, a little below the central part. It is flat, bounded by narrow, low, sharply angulated ridges and bears closely spaced concave lunulae. The remainder of whorl surface above, laterally, and below, bears nearly uniformly sized and spaced revolving lirae separated by shallow concave troughs. About 12 troughs occur on the upper surface. Growth lines indicated by closely and nearly uniformly spaced sharp lirae, are less prominent than revolving ones. They extend gently backward from the suture, are nearly straight on the upper surface and then curve backward on outer face to the selenizone. Below the selenizone, similar growth lines extend forward but at the sharp basal angulation they turn into the shallow sinus of the upper part of a gentle S-shaped curve.

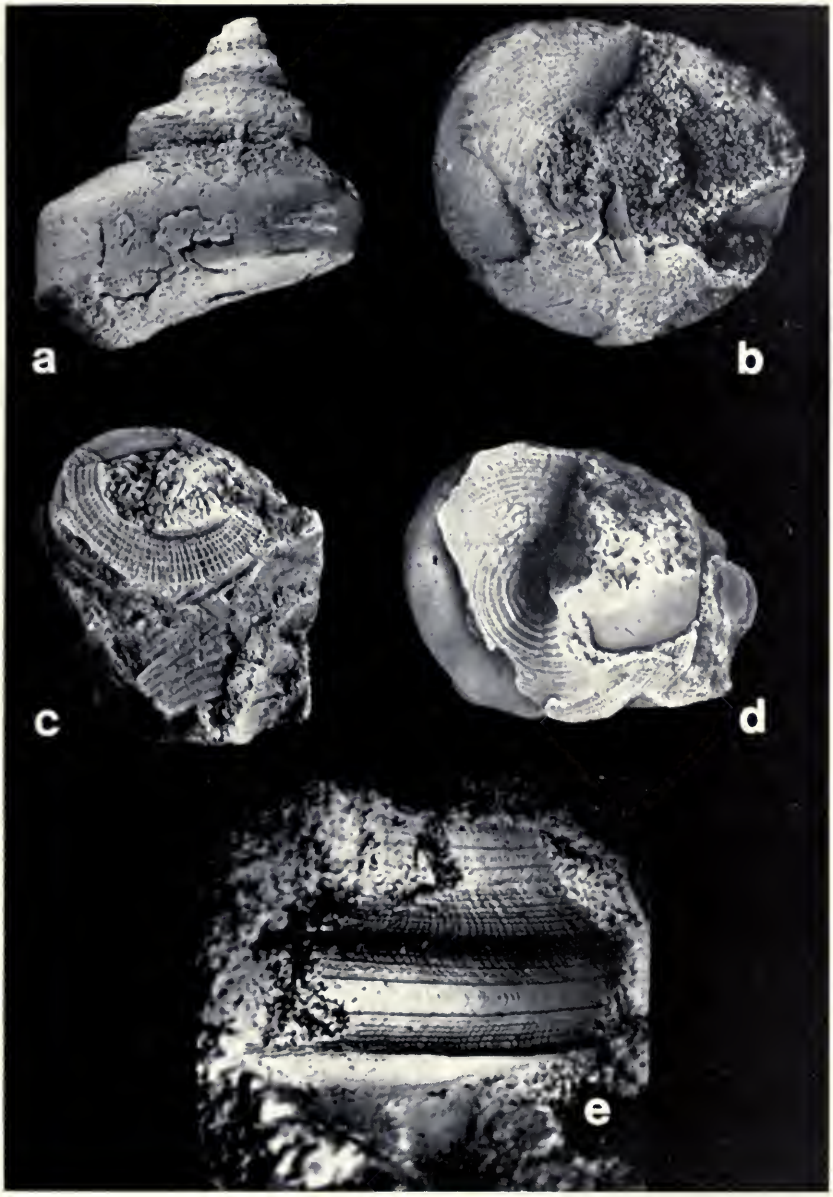


FIG. 43. *Borestus chesterensis* (Meek and Worthen, 1861). **(a)** dorsal view, × 2.5 (31040-1); **(b)** umbilical view showing basal ornaments, × 2.5, same specimen; **(c)** oblique apical view showing ornamentation on the upper surface, × 3.5 (30341); **(d)** umbilical view showing basal ornamentation, × 3.5, same specimen; **(e)** external mold showing surface ornamentation, × 2.5 (31040-2). All FMNH UC.

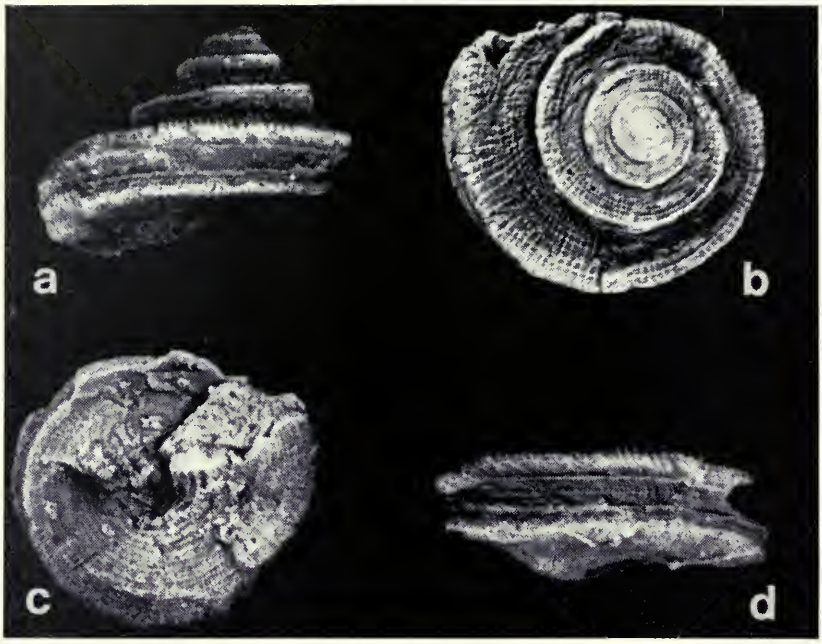


FIG. 44. *Borestus* cf. *B. chesterensis* (Meek and Worthen, 1861). **(a)** dorsal view of a crushed specimen (30474-1); **(b)** apical view, same specimen; **(c)** umbilical view, same specimen; **(d)** dorsal view shownig selenizonal characters (30474-2) All FMNH UC. All × 3.5.

Comparison.—This species differs from *B. wrighti* Thomas, 1939 (pp. 54–55, pl. 3, figs. 1a–b), by the slightly slanting outer whorl face and stronger upper angulation. It differs from *B. pagoda* (Newell, 1935, pp. 346–347, pl. 36, figs. 4, 4a), a Pennsylvanian species from Oklahoma, by having weaker collabral ornamentation. It also differs from *B. worthenioides* (Girty, 1934, pp. 251–253, figs. 8, 9), a Pennsylvanian form from Arkansas, by having a less sharp lower angulation and lack of described ornamentation.

Measurements (in mm.).—Measurements of the best specimen are: height—17.2; width—16.8; spire height—4.7; final whorl height—12.5; pleural angle—77 degrees.

Material, stratigraphic positions, and localities.—Seven specimens, six imperfect and mostly exfoliated and one partial internal mold in fine-grained sandstone from three localities. Two specimens FMNH UC 31040, Glen Dean Limestone, Locality 15; one specimen FMNH UC 30341 and three specimens FMNH UC 30342, Glen Dean Lime-

stone, Locality 12; one specimen FMNH UC 26800, Shetlerville bed of Renault Limestone, Locality 26.

Borestus cf. **B. chesterensis** (Meek and Worthen, 1861). Figure 44.

Discussion.—Specimen about 15 mm. in diameter, height not determinable. It resembles *B. chesterensis* in most respects but the transverse lirae of the upper whorl surface are relatively stronger, producing a distinctly reticulate pattern, and the outer face is somewhat concave with more pronounced angulation above. A spiral lira is present at the center of selenizone.

Material, stratigraphic position, and locality.—Two specimens, one fairly complete but crushed, FMNH UC 30474, Golconda Limestone, Locality 9.

Genus **Phymatopleura** Girty, 1939

Type species.—*Orestes nodosus* Girty, 1912.

Definition.—Turbiniform or trochiform, with depressed selenizone above basal angulation; ornament sharp spiral and collabral threads with one or more spiral rows of nodes high on whorl face (Knight et al., 1960).

Stratigraphic range.— Lower Mississippian to Lower Permian.

American Mississippian species.—Only a single unnamed species, viz., *Phymatopleura* sp. Yochelson and Dutro, 1960 (p. 139, pl. 13, figs. 22–24) has been reported from the Lower Mississippian of northern Alaska. The two species described here seem to be the first reported from the Upper Mississippian.

Phymatopleura nyi new species. Figure 45.

Definition.—Shell turreted, height slightly greater than width, anomphalous. Upper surface of whorl sloping, bearing a row of spiral nodes near the suture and a second at about mid-width of surface. The surface bordered laterally by a third row. Nodes of successive rows connected by low, rounded growth lines which extend backward from suture. Space between second row and border on last whorl bears a spiral lira that begins to bear nodes similar to others but less conspicuous. Outer whorl surface with two sharply elevated lirae which border the selenizone. Below the lower one, the whorl curves into the lower whorl surface which bears eight or more revolving lirae, weaker than those previously mentioned. Aperture unknown. Growth lines not evident except on upper whorl surface.

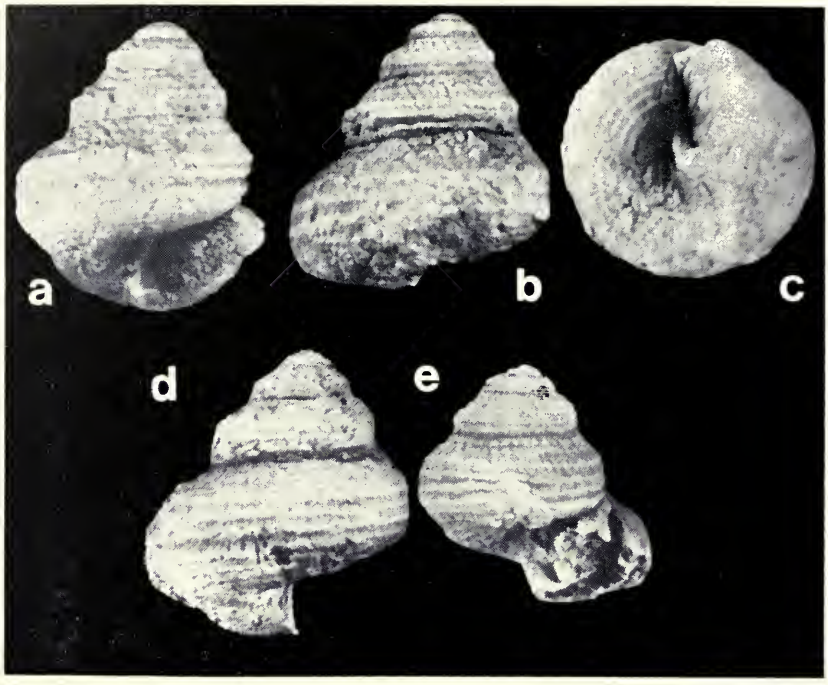


FIG. 45. *Phymatopleura nyi* n. sp. **(a)** apertural view of holotype, × 5, (30479); **(b)** dorsal view, × 5, same specimen; **(c)** umbilical view, × 5, same specimen; **(d)** dorsal view, × 5 (30475-A); **(e)** apertural view, × 7 (30475-B). All FMNH UC.

Comparison.—This species differs from *P. nodosus* (Girty, 1911, p. 137; 1915, pp. 156–158, pl. 22, figs. 7–10), a Pennsylvanian species from Oklahoma, by having less pronounced nodes, and a narrower selenizone with stronger bordering cords.

Measurements.—Measurements are given in Table 24.

TABLE 24.—Measurements (in mm.) of *Phymatopleura nyi* n. sp.

Specimen FMNH UC	H	W	Pa
30479	7.8	6.5	56°
30475-A	8.1	6.7	64°
30475-B	4.1	3.6	57°

Material, stratigraphic position, and locality.—Three specimens from a single locality. Holotype: FMNH UC 30479, two specimens FMNH UC 30475, Golconda Limestone, Locality 9.

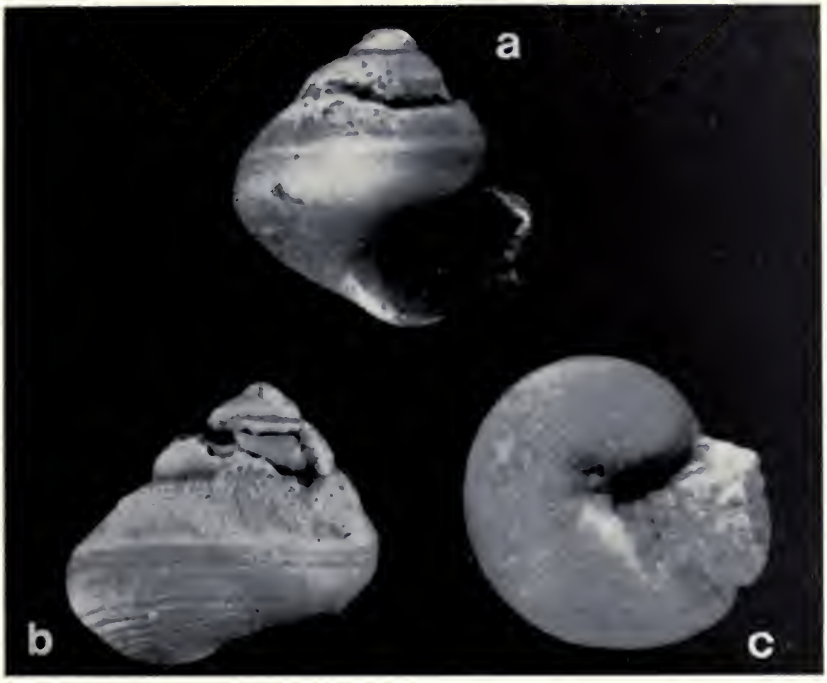


FIG. 46. *Phymatopleura* sp. indet. **(a)** apertural view (FMNH UC 31707); **(b)** dorsal view, same specimen; **(c)** umbilical view, same specimen. All × 7.

Phymatopleura sp. indet. Figure 46.

Description.—This species differs from *P. nyi* by its less turreted appearance, wider pleural angle, and presence of more numerous but weaker revolving lirae on upper whorl surface where eight rounded lirae are crossed by weaker and backwardly swinging transverse lirae producing a reticulate ornament pattern. This surface is convex above and concave below. Selenizone bounded by weaker lirae and also ornamented by a third revolving lira at the center and closely spaced curved lunulae. About 12 revolving lirae on the base are relatively wider than those on the upper surface and separated by very narrow interspaces.

Measurements (in mm.)—Measurements on the better preserved specimen are: height—5.7; width—5.8; pleural angle—78 degrees.

Material, stratigraphic position, and locality.—Two somewhat immature specimens, FMNH UC 31707, Golconda Limestone, Locality 13.

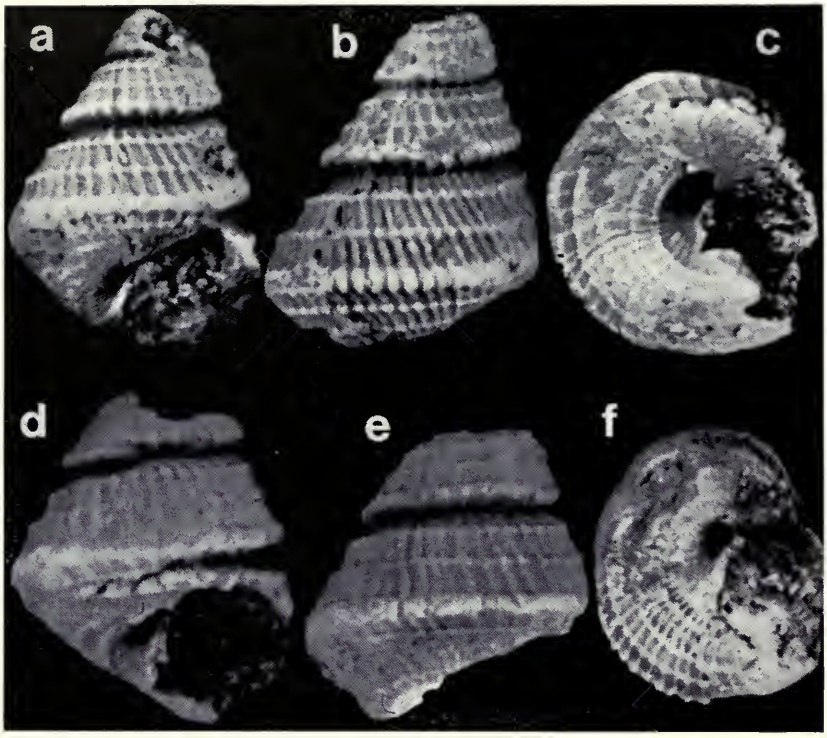


FIG. 47. *Kinkaidia cancellata* n. sp. **(a)** apertural view of holotype (30910); **(b)** dorsal view, same specimen; **(c)** umbilical view, same specimen; **(d)** apertural view (56302); **(e)** dorsal view, same specimen; **(f)** umbilical view, same specimen. All FMNH UC. All × 7.

Superfamily *Trochonematacea* Zittel, 1895

Family Trochonematidae Zittel, 1895

Genus **Kinkaidia** new genus

Type species.—*Kinkaidia cancellata* n. sp.

Definition.—Subturbiniform, with spiral angulation at periphery but somewhat below middle of whorl; ornamented with three spiral cords on upper whorl face and four to five on lower whorl face, crossed by collabral lirae, forming low nodes at intersections.

Stratigraphic range.—Upper Mississippian.

Kinkaidia cancellata new species. Figure 47.

Description.—Subturbiniform, narrowly phaneromphalous. Upper whorl surface flattened and rather steeply sloping down to

periphery, bearing three revolving cords, one of which is stronger at periphery. These cords are crossed by thinner but sharp, uniformly strong and spaced transverse lirae which are straight and extend backward at an angle of about 10 to 15 degrees from vertical, low nodes being formed at the intersections. Surface below peripheral angulation more progressively convex and then abruptly curved into umbilicus, ornamented by 4 to 5 somewhat weaker revolving lirae. These are crossed by transverse lirae, almost as strong as those of upper surface, which are convex backward. Funnel-like columella reflected over umbilicus. Aperture unknown.

Measurements (in mm.).—FMNH UC 30910: width—5; pleural angle—46 degrees.

Materials, stratigraphic position, and locality.—Two rather incomplete specimens from a single locality. Holotype: FMNH UC 30910, other specimen FMNH UC 56302, Kinkaid Limestone, Locality 27.

Suborder Patellina von Ihering, 1876

Superfamily Patellacea Rafinesque, 1815

Family Metoptomatidae Wenz, 1938

Genus **Lepetopsis** Whitfield, 1882

Type species.—Patella levettei White, 1882.

Definition.—Shell thin, patelliform, with open horseshoe-shaped muscle scar; aperture slightly in front of center; posterior slope convex, anterior straight or concave.

Stratigraphic range.—Mississippian to Middle Permian.

American Mississippian species.—Only two species, *L. chesterensis* (Worthen, 1884) and *L. levettei* (White, 1882), which also is redescribed by Knight (1941, pp. 167–168, pl. 2, figs. 2a–2c), from the Salem Limestone of Indiana, have been reported.

Lepetopsis chesterensis Worthen, 1884. Figure 48.

Lepetopsis chesterensis. Worthen, 1884, Bull. Ill. State Mus. Nat. Hist., no. 2, p. 25; Worthen, 1890, Geol. Survey Ill., 8, pp. 140–141, pl. 25, figs. 1–1a; Mather, 1916, Bull. Sci. Lab. Denison Univ., 18, p. 231.

Description.—Shell lozenge-shaped, apex subcentral and seemingly directed anteriorly. Width of shell very slightly broader posteriorly. Cone relatively low with posterior slope very slightly

convex and anterior slope slightly concave, profile of sides nearly straight. A shallow sinuous depression extrudes anteriorly from the apex and increases rapidly in width to the margin. A somewhat similar but much less conspicuous and wider depression occurs on

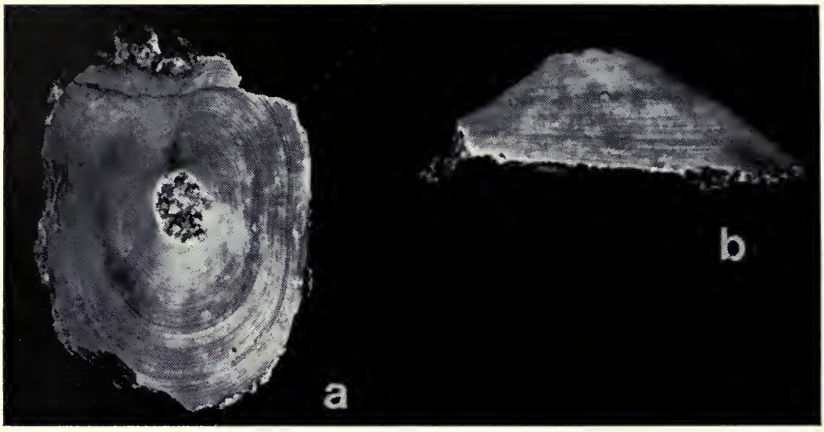


FIG. 48. *Lepetopsis chesterensis* Worthen, 1884. **(a)** apical view (FMNH UC 25172); **(b)** right lateral view, same specimen. All × 2.5.

the right side of the shell. Surface ornamented by thin, flat, numerous, somewhat irregularly but closely spaced growth lines which arch upward in crossing the depressions. Shell thin.

Discussion.—These specimens are almost exactly similar to Worthen's specimens except for the inconspicuous depression on the right side of the shell. When Worthen described this species, he, like most other earlier workers, mistakenly regarded the anterior of these shells as posterior. *L. chesterensis* differs from *L. levettei* in

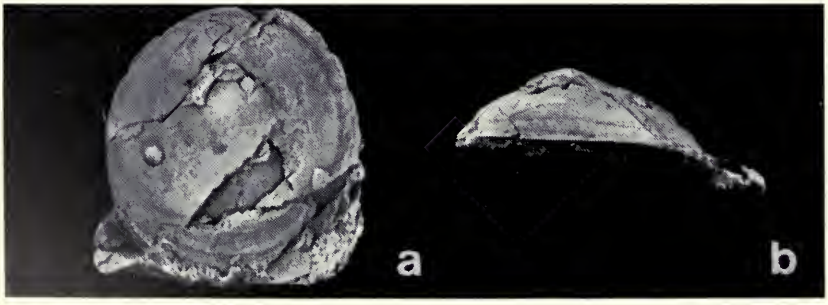


FIG. 49. *Lepetopsis* sp. indet. **(a)** apical view (FMNH UC 31694); **(b)** right lateral view, same specimen. All × 3.5.

being a lower and less oval cone in outline. It also has sinuous depressions. It differs from the Pennsylvanian species, *L. parrishi* Gurley, 1884 and *L. peregrina* Newell, 1935 (both in Newell, 1935) by being a lower cone, less oval in shape, and more elongated in profile as seen from the side.

Measurements (in mm.).—FMNH UC 25172: length—20.5, width—15.2, height—9.3.

Material, stratigraphic positions, and localities.—Two specimens from one locality, FMNH UC 25172, Lower Okaw (Marigold Oolite), Locality 24; FMNH UC 30335, Glen Dean Limestone, Locality 12.

Lepetopsis sp. indet. Figure 49.

Description.—Shell rather small, very low, and almost circular, apex slightly in front of the center. Anterior slope faintly concave but becomes straight near the margin. Posterior slope straight for the first half and convex thereafter. Lateral slopes nearly the same as posterior. Ornament unknown, but three or four growth lines are apparent near the margin. Shell thin.

Comparisons.—This form is very different from the two other Mississippian species. It is closest to *L. parrishi* Gurley, 1884, a Pennsylvanian species redescribed by Newell (1935, pp. 351–352, pl. 35, figs. 1–2), but it is more circular in outline and has a lower cone with more gently sloping sides.

Measurements (in mm.).—FMNH UC 31694: length—9.5; width—9.1; height—4.0.

Material, stratigraphic position, and locality.—Single exfoliated specimen FMNH UC 31694, Lower Golconda Limestone, Locality 13.

Suborder Trochina Cox and Knight, 1960

Superfamily Platyceratacea Hall, 1859

Discussion.—Fossil records show that the platyceratid gastropods were sedentary in habit and are thought to have been coprophagous on crinoids and cystoids. They are commonly found adhering over the anal vent on calyxes with the aperture closely conforming to the shape of the calyx. Such association was first reported in 1843 by Austin and Austin (p. 73). Association with a blastoid has been reported by Meek and Worthen (1867, pp. 262–263) and by Levin and

Fay (1964, pp. 22–29, pls. 1, 2); this rare symbiotic association may be due to the construction of the blastoids making them less suitable hosts for these gastropods. Two of the specimens of the present collection are attached to echinoderms, one to the anal vent of a crinoid (fig. 53a–d) and the other to the side of a specimen of *Pentremites godoni* (fig. 57a–d).

Bowsher (1955) pointed out the vital significance of the evolution of this superfamily whose coprophagous and sedentary habit was much influenced by the morphology and geologic history of echinoderms. He traced the phylogeny from *Naticonema* Perner by various steps to the typical smooth *Platyceras*. The general trend was the loss of ornamentation and initial regularity of coiling. The extinction of *Platyceras* may have been related to the extinction of camerate crinoids (Bowsher, 1955, p. 9).

These gastropods have a horseshoe-shaped muscle scar (Meek and Worthen, 1868, p. 457; Yochelson, 1956, p. 208, pl. 23, figs. 25, 26) similar to that possessed by many other cap-shaped shells (Yonge, 1947). They are all clinging forms, varying from those that are sedentary to others entirely incapable of movement in the adult stage. The presence of only a single ctenidium is assumed by analogy with other advanced prosobranchs.

Family Platyceratidae Hall, 1859

Genus **Platyceras** Conrad, 1840

Type species.—*Pileopsis vetusta* Sowerby, 1829.

Definition.—Forms varying from the naticiform through disjunct to capuliform. Some earlier species with spiral and collabral threads or with collabral lines, others with hollow spines arising as marginal tubes. Apertural margin regular to irregular, many being deeply sinuate, conforming to irregularities of the echinoderm to which it was attached during life.

Stratigraphic range.—Silurian to Middle Permian.

Discussion.—*Platyceras* comprises an aggregate of at least six subgenera (Yochelson, 1956; Knight et al., 1960). Only two, viz., *Orthonychia* and *Platyceras sensu stricto*, are represented in the present collection of which the former is much more common. The main difference between these two forms is that *Platyceras* has one or two coiled whorls, but *Orthonychia* does not.

Subgenus **Platyceras** Conrad, 1840

Type species.—*Pileopsis retusta* Sowerby, 1829.

Definition.—Irregularly capuliform with one or two early whorls coiled. Protoconch vermiform. Ornament consisting of spiral and collabral threads but commonly wanting.

Stratigraphic range.—Silurian to Mississippian.

American Mississippian species.—About 18 named species and several unnamed specimens have been described. Some of the species were based on a single specimen, and the nature of the first whorls is not known for others. Most of the species are from Lower Mississippian strata and only four are of Chester age. One of the latter species was described and figured as *Platyceras subrotundum* Snider, 1915 (p. 118, pl. 7, figs. 10, 11). *Platyceras subelegans* Girty, 1910 (p. 232) was redescribed and figured by Yochelson, 1969b (pp. 31–32, pl. 5, figs. 26, 27, 35). *Acroculia oralis* Stevens, 1858 (p. 261) was not

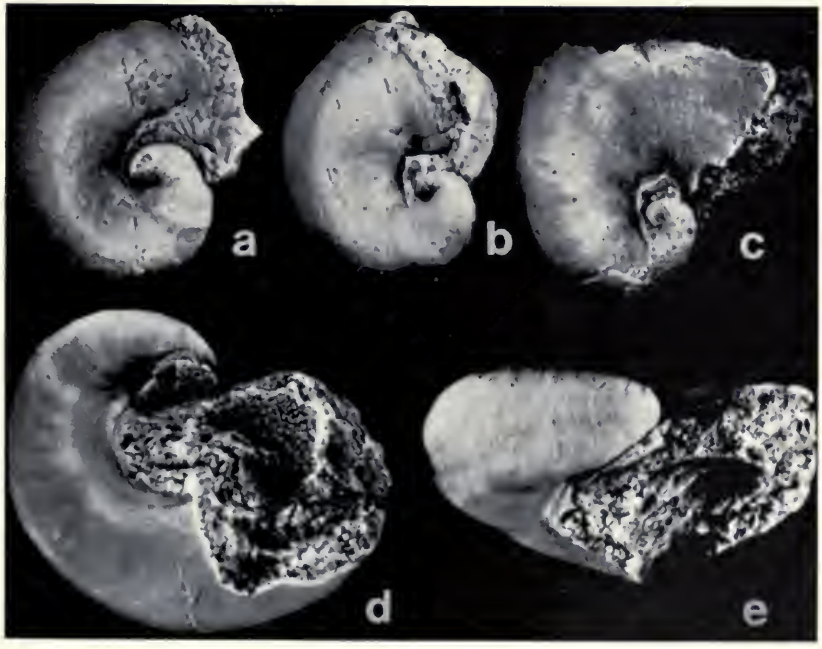


FIG. 50. *Platyceras* (*Platyceras*) *subrotundum* Snider, 1915. **(a)** apical view (30421); **(b)** apical view (30562); **(c)** apical view (30352-A); **(d)** umbilical view (30352-B); **(e)** apertural view, same specimen. All FMNH UC. All × 3.

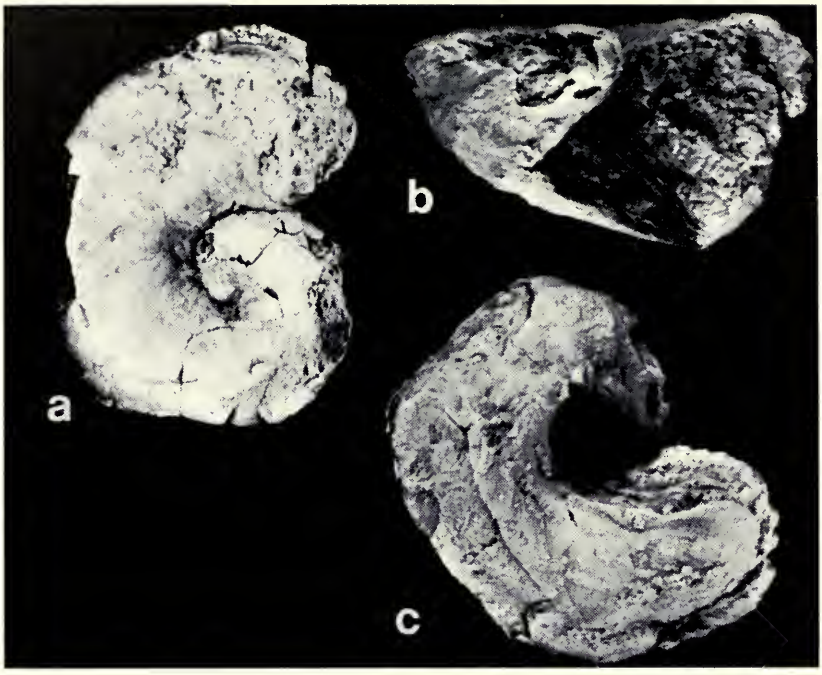


FIG. 51. *Platyceras* (*Platyceras*) sp. indet. 1. **(a)** apical view (FMNH UC 25253); **(b)** apertural view, same specimen; **(c)** umbilical view, same specimen. All × 3.

figured and *Platyceras* (*Platyceras*) sp. Yochelson and Dutro, 1960 (pp. 140–141, pl. 14, fig. 28) was not named.

Platyceras (Platyceras) subrotundum Snider, 1915. Figure 50.

Platyceras subrotundum. Snider, 1915, Bull. Okla. Geol. Surv., **24**, p. 118, pl. 7, figs. 10–11; Easton, 1942, Bull. Ark. Geol. Surv. **8**, pl. 11, fig. 13.

Description.—Shell medium size, first volution discoidal, coiled approximately in a plane. Enlargement rapid during the first volution, slower but uniform thereafter. Cross-section of final whorl subelliptical. Upper surface of final whorl somewhat flattened, sloping toward the center. Lateral surface sharply rounded and umbilical surface gently convex. Shell thin.

Comparisons.—This species differs from *Platyceras* (*P.*) *haliotoides* Meek and Worthen, 1860 (Meek and Worthen, 1868, p. 458, pl. 14, figs. 3a–b), a Kinderhookian species, by having less rapidly expanding whorls and less convex upper surface. It can be differentiated from *P.* (*P.*) *glenparkensis* S. Weller (1906 pp. 460–461, pl. 2, figs.

30, 31), a Lower Mississippian species, by its less convex upper surface, more closely coiled whorls, and less elliptical aperture.

Measurements (in mm.).—Greatest length—18; thickness—13.

Material, stratigraphic position, and localities.—Six specimens, all internal molds, from three localities. Four specimens FMNH UC 30352, Glen Dean Limestone, Locality 12; one specimen FMNH UC 30421, Glen Dean Limestone, Locality 28; one specimen FMNH UC 30562, Glen Dean Limestone, Locality 29.

Platyceras (Platyceras) sp. indet. 1. Figure 51.

Description.—Shell medium size, with flattened upper surface and angular umbilical rim. First one or two whorls closely coiled, but latter whorls unknown. Upper surface flattened, sloping down toward center. Lateral surface sharply sloping downward to form the angulated umbilical rim. Transverse outline of latest whorl triangular.

Discussion.—This form is very different from other Mississippian *Platyceras*. The flattened upper surface together with the triangular whorl outline and steeply sloping lateral surface are its unique features. The closest form is *Platyceras* (*P.*) *reversum* Hall, 1860 (see Meek and Worthen, 1868, pp. 508-509, pl. 15, figs. 4a, b) from the Burlington Limestone, but this species is sinistrally coiled and its aperture is subcircular.

Measurements (in mm.)—FMNH UC 25253: length—17; thickness—13.

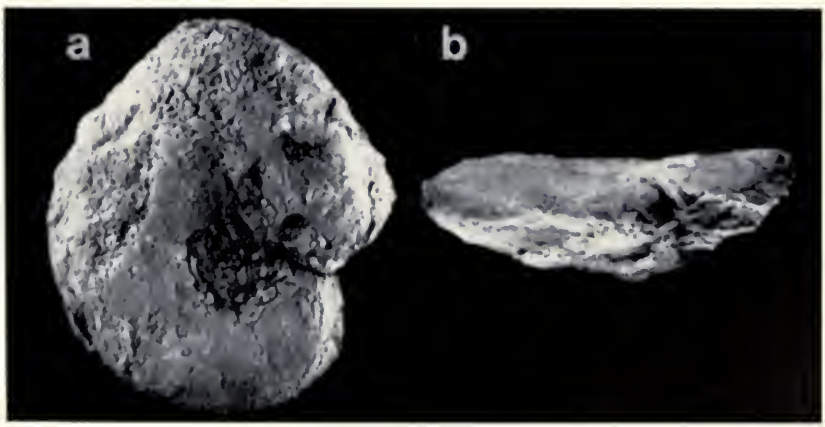


FIG. 52. *Platyceras* (*Platyceras*) sp. indet. 2. **(a)** apical view (FMNH UC 30813); **(b)** apertural view, same specimen. All × 2.

Material, stratigraphic position, and locality.—One internal mold FMNH UC 25253, Lower Okaw (Golconda), Locality 30.

Platyceras (Platyceras) sp. indet. 2. Figure 52.

Description.—Shell flattened, first 1 to 1½ whorls closely coiled, enlarging regularly; latter whorls unknown. Upper and lower surfaces gently rounded.

Discussion.—Although this form is quite different from all other described Mississippian species of the United States, it would be improper to give a specific name to such a poorly preserved single specimen.

Measurements (in mm.).—FMNH UC 30813: length—25; thickness—8.

Material, stratigraphic position, and locality.—One poorly preserved internal mold FMNH UC 30813, Renault Limestone, Locality 31.

Subgenus **Orthonychia** Hall, 1843

Type species.—*Platyceras* (*Orthonychia*) *subrectum* Hall, 1859.

Definition.—Very similar to *Platyceras sensu stricto*, but without coiling except that the vermiform protoconch may be fused to shell. Ornament either similar to *Platyceras sensu stricto*, or more commonly consisting of strong longitudinal folds produced by sinuses over strong salients on the crinoid calyx.

Stratigraphic range.—? Silurian, Lower Devonian to Middle Permian.

Discussion.—Lack of ornament and great variation make a taxonomic differentiation extremely difficult. Approximately 35 Mississippian species have been assigned to this subgenus, of which eight are of Chester age. In the past, most authors have paid little attention to individual or ontogenetic variation and have described species based on single or very few specimens. Thorough restudy certainly would indicate a much smaller number of valid species. The eight figured Chester species are:

Platyceras (?) sp. cf. *P. acutirostris* Hall, 1857 reported by Elias (1958, p. 21, pl. 2, fig. 12), Late Mississippian, Southern Oklahoma.

Platyceras (*Orthonychia*) *chesterense* Meek and Worthen, 1867 (see Keyes, 1894, pp. 191–192, pl. 54, figs. 1a–1d), Chester Group, Illinois, Kentucky, and Missouri.

Platyceras (*Orthonychia*) *compressum* Girty, 1910 (p. 232; see Yochelson, 1969b, p. 32, pl. 5, figs. 28–30, 37, 40), Batesville Sandstone and Fayetteville Shale, Arkansas.

Orthonychia mayesense Snider, 1915 (p. 118, pl. 7, figs. 8, 9), Mayes Formation, Oklahoma.

Capulus striatulus Girty, 1927 (pp. 430–431, pl. 25, figs. 33–38), Brazer Limestone, Southeastern Idaho.

Capulus striatulus var. *gracilis* Girty, 1927 (p. 431, pl. 25, figs. 39–41), Brazer Limestone, Southeastern Idaho.

Platyceras (*Orthonychia*) *subplicatum* (Meek and Worthen, 1866) (see Meek and Worthen, 1868, p. 457, pl. 14, figs. 4a–4c), Chester Group, Illinois and Ohio.

Platyceras (*Orthonychia*) sp. Yochelson and Dutro, 1960 (p. 141, pl. 14, figs. 17–19), Upper Mississippian, Northern Alaska.

Platyceras (Orthonychia) chesterense Meek and Worthen, 1867

Platyceras (*Orthonychia*) *chesterense* Meek and Worthen, 1867, Proc. Acad. Nat. Sci., Phila., p. 265.

Platyceras chesterense Keyes, 1888, Proc. Amer. Philo. Soc., **25**, pl. 1, figs. 4, 5.

Capulus chesterensis Keyes, 1890, Amer. Geol., **6**, p. 9; Keyes, 1891, Proc. Acad. Nat. Sci., Phila., **42**, p. 176, pl. 2, figs. 13a–13d.

Orthonychia chesternese Keyes, 1894, Mo. Geol. Surv., **5**, pp. 191–192, pl. 54, figs. 1a–1d.

Description.—Shell small to medium-sized, obliquely conical, generally with the development of longitudinal salients and re-entrants, each about five in number. Shape exceedingly irregular, but commonly the earlier portion of the shell is curved, the tiny protoconch hook-shaped. Some shells expand regularly for the first two-thirds and then more rapidly, but in others the rapid expansion of the shell begins much earlier. Usually the salients, separated by corresponding re-entrants, extend from apex to aperture, but in some specimens their appearance is delayed to the latter half of the shell or they are extremely weak. Aperture irregularly subcircular, oval to pentagonal. Lip thin with rounded sinuses at the terminals of salients. Growth lines very fine, concave downward on the salients and upward on the re-entrants.

Discussion.—All specimens in the present collection which come from the Lower and Middle Chester stages are grouped as a single species, *Platyceras* (*O.*) *chesterense*. This is generally characterized by an obliquely conical shape with five, more or less, salients and

re-entrants. Otherwise, tremendous variations occur imposed by the different substrate to which these animals were attached in life. It is only possible to discriminate these variants provisionally without assigning them to different specific names.

Platyceras (*O.*) *chesterense* has been found commonly attached to the vaults of crinoids and the sides of blastoids. Keyes (1894, p. 191) reported that specimens from Kentucky are attached to *Pterotocrinus acutus*, *P. bifurcatus*, and *P. depressus*. Meek and Worthen (1867, p. 265) recorded one adhering to the side of *Pentremites godoni*. A few specimens in the present collection are overgrown by bryozoans.

Measurements.—Measurements are given in Table 25.

TABLE 25.—Measurements (in mm.) of *Platyceras* (*Orthonychia*) *chesterense* Meek and Worthen, 1867.

Variant	Specimen FMNH UC	Height	Greatest Width
1	25326-A	12.5	9.5
1	25252	30.0	23.0
1	25095	8.0	6.8
2	30353-A	21.0	13.0
2	30353-B	21.0	12.9
3	25254-A	8.0	5.5
3	25096	13.0	8.5
3	30233	10.8	6.9
3	25173	9.0	6.0
3	30266	15.5	9.2
4	25144	11.0	8.0
4	26940-A	18.7	7.0
4	26940-B	10.5	4.9

Materials.—Ninety-four specimens from numerous localities in Illinois and western Kentucky.

The following variants of *Platyceras* (*O.*) *chesterense* can be recognized:

VARIANT 1. Figures 53–54, 59.

This variant shows great variability but generally is either smooth or with a single broad and low salient extending from near the apex to the aperture. If all five salients are present, they generally occur only near the aperture. These individuals are commonly attached to crinoids. The aperture may be subpentagonal, or subcircular to oval.

Two of the specimens of *Orthonychia chesterense* figured by Keyes (1894, pl. 54, figs. 1b, 1d) possess the characters of this variant. *Capulus cutirostris* Hall (figured by Keyes, 1894, pl. 54, figs. 2a–2c as *Orthonychia acutirostre*), *Platyceras boonvillense* A. S. Miller, 1891

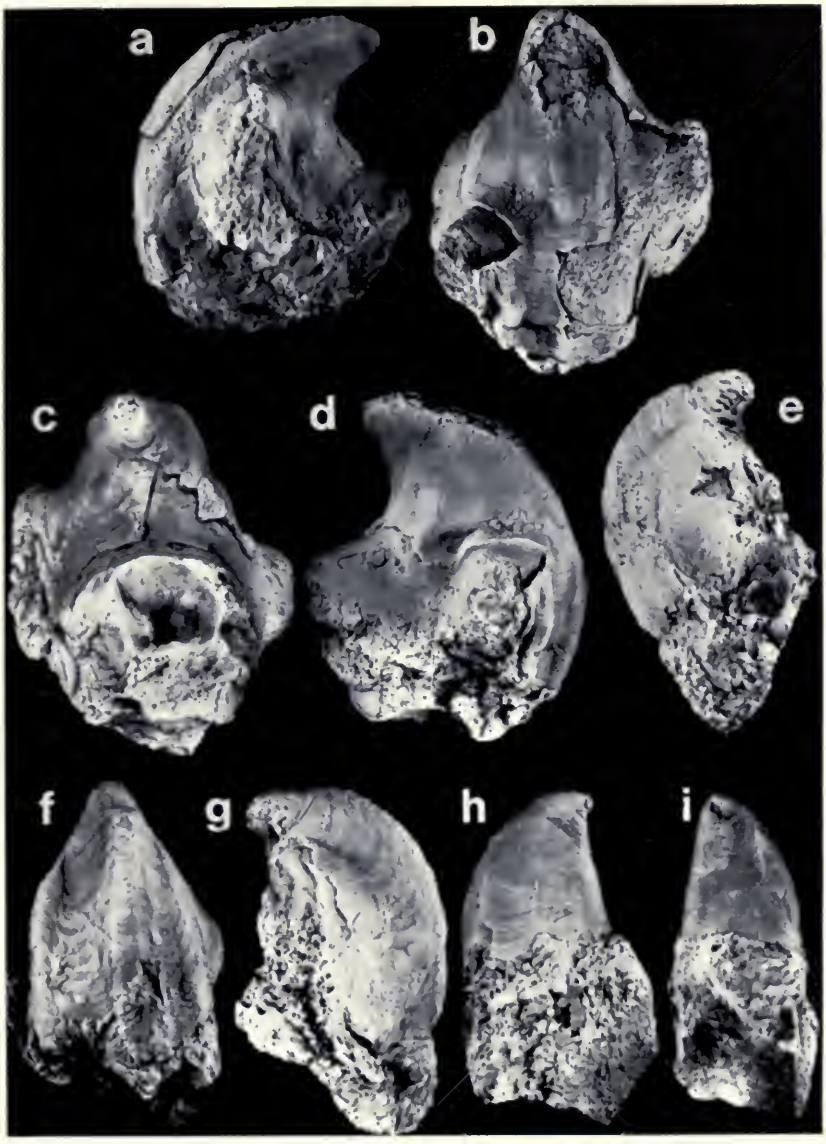
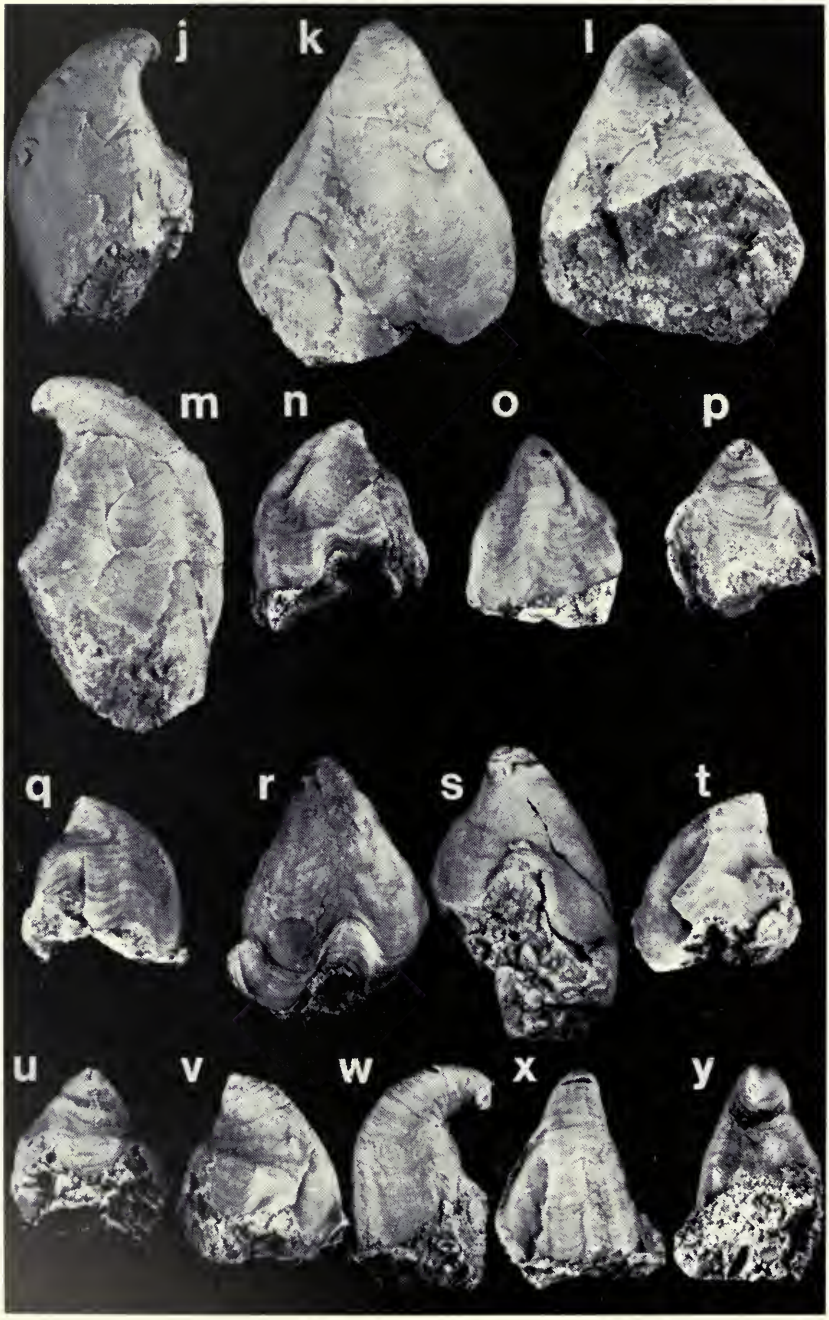


FIG. 53. *Platyceras (Orthonychia) chesterense* Meek and Worthen, 1867, variant 1. **(a)** left lateral view of a specimen attached to a crinoid, × 1.5 (25252); **(b)** anterior view, × 1.5, same specimen; **(c)** apertural view, × 1.5, same specimen; **(d)** right lateral view, × 1.5, same specimen; **(e)** left lateral view, × 3 (26959-B); **(f)** anterior view, × 3, same specimen; **(g)** right lateral view, × 3, same specimen; **(h)** left lateral view, × 3 (26959-C); **(i)** apertural view, × 3, same specimen.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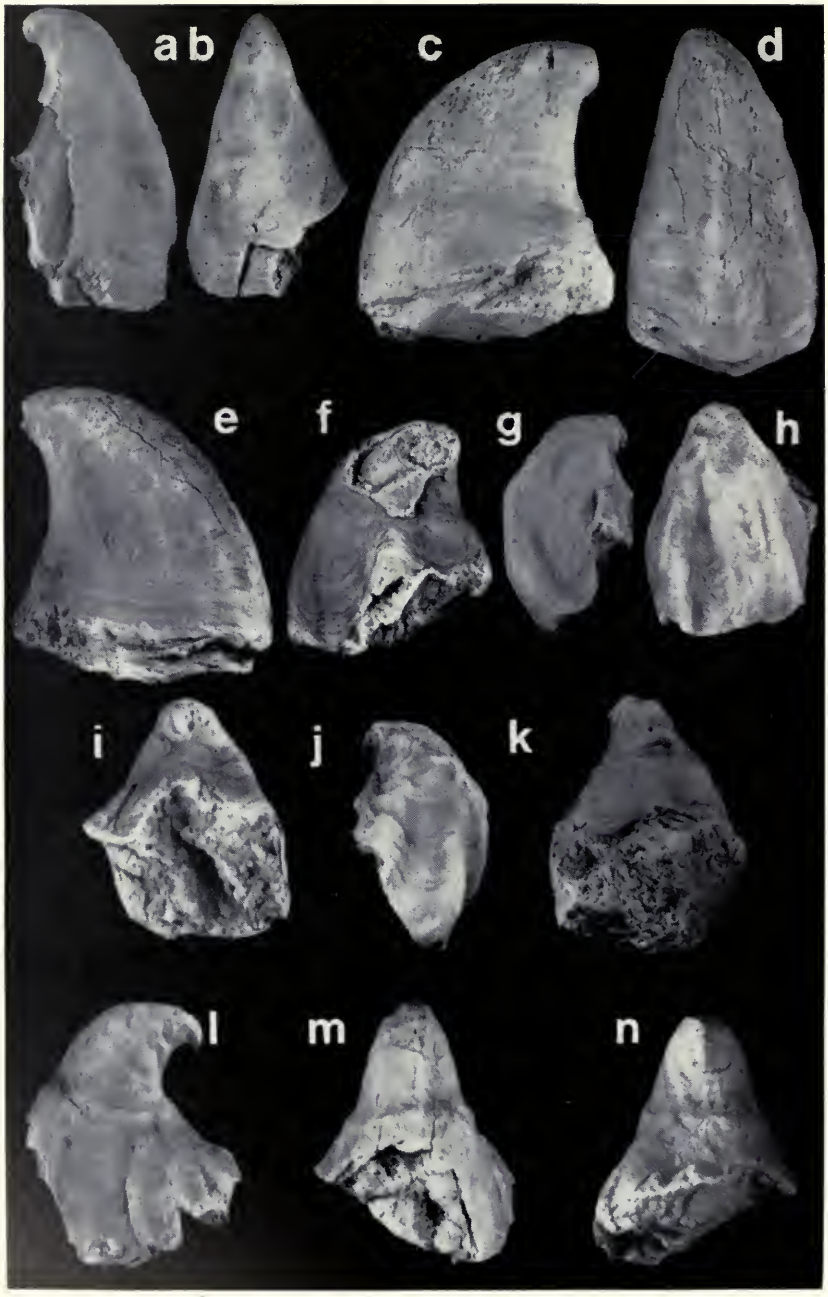
(p. 82, pl. 14, figs. 15, 16), *Platyceras* (*Orthonychia*) *cornuforme* Winchell, 1863 (figured by Hyde, 1953, pl. 47, figs. 15, 16), *Platyceras cyrtolites* McChesney, 1860 (figured by Keyes, 1894, pl. 53, fig. 15), *Platyceras uncum* Meek and Worthen, 1867 (see Meek and Worthen, 1873, pp. 516–517, pl. 17, fig. 1), *Platyceras vomerium* Winchell, 1863 (figured by S. Weller, 1901, as *Capulus vomerium*, pl. 20, fig. 15), and *Platyceras* (*O.*) *waverlyensis* Hyde, 1953 (pp. 334–335, pl. 47, figs. 1–6) may fall within the scope of this variant. All of these species, except *Orthonychia chesterense*, are Middle and Lower Mississippian in age.

Material, stratigraphic positions, and localities.—Forty-eight specimens from 17 localities. Seven specimens FMNH UC 26959, Renault Limestone, Locality 10; nine specimens FMNH UC 30364, Glen Dean Limestone, Locality 12; two specimens FMNH UC 26939, Paint Creek Shale, Locality 34; five specimens FMNH UC 25095, Lower Okaw Limestone, Locality 11; one specimen FMNH UC 30265, Golconda Limestone, Locality 38; three specimens FMNH UC 26782, Shetlerville bed (basal shale) of Renault Limestone, Locality 35; three specimens FMNH UC 56307 and one specimen FMNH UC 25252, Lower Okaw (Golconda) Limestone, Locality 30; one specimen FMNH UC 26889, Paint Creek Limestone, Locality 32; two specimens FMNH UC 25326, Lower Okaw Limestone, Locality 2; four specimens FMNH UC 25130, Lower Okaw (Evansville Oolite), Locality 3; three specimens FMNH UC 26831, Shetlerville bed of Renault Limestone, Locality 36; two specimens FMNH UC 30808a, Renault Limestone, Locality 37; one specimen FMNH UC 30794, Renault Limestone, Locality 7; one specimen FMNH UC 30493, Golconda Limestone, Locality 9; one specimen FMNH UC 26807, Shetlerville bed of Renault Limestone, Locality 26; one specimen FMNH UC 30973, Top of Golconda Limestone, Locality 39; and one specimen FMNH UC 30093, Renault Limestone, Locality 33.

FIG. 53, *Continued.*—*Platyceras* (*Orthonychia*) *chesterense* Meek and Worthen, 1867, var. 1. **(j)** left lateral view (26889); **(k)** anterior view, same specimen; **(l)** apertural view, same specimen; **(m)** right lateral view, same specimen; **(n)** left lateral view (25095-C); **(o)** anterior view, same specimen; **(p)** apertural view, same specimen; **(q)** right lateral view, same specimen; **(r)** anterior view (25326-A); **(s)** right lateral view, same specimen; **(t)** left lateral view (25326-B); **(u)** apertural view, same specimen; **(v)** right lateral view, same specimen; **(w)** left lateral view (26959-A); **(x)** anterior view, same specimen; **(y)** apertural view, same specimen. All FMNH UC. All × 3.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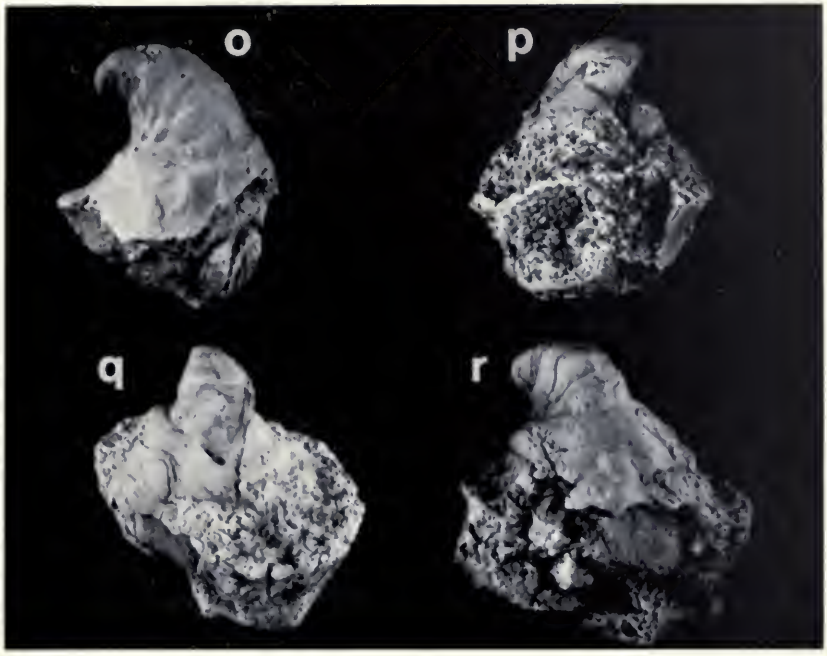

FIG. 54, *Continued.—Platyceras (Orthonychia) chesterense* Meek and Worthen, 1867, var. 1. **(o)** right lateral view, same specimen; **(p)** left lateral view (56307-A); **(q)** anterior view, same specimen; **(r)** right lateral view, same specimen. All FMNH UC. All × 3.

VARIANT 2. Figures 55–56, 59.

This variant is characterized by having five to six or rarely more strong, irregularly developed salients and corresponding deep re-entrants. The salients on the anterior side are more prominent than the others and commonly bifurcate. The earlier one-fourth or less of the shell is smooth and without salients and re-entrants. These start to appear with increasing prominence beyond that point and reach the apertural margin. Aperture irregularly pentagonal to sub-

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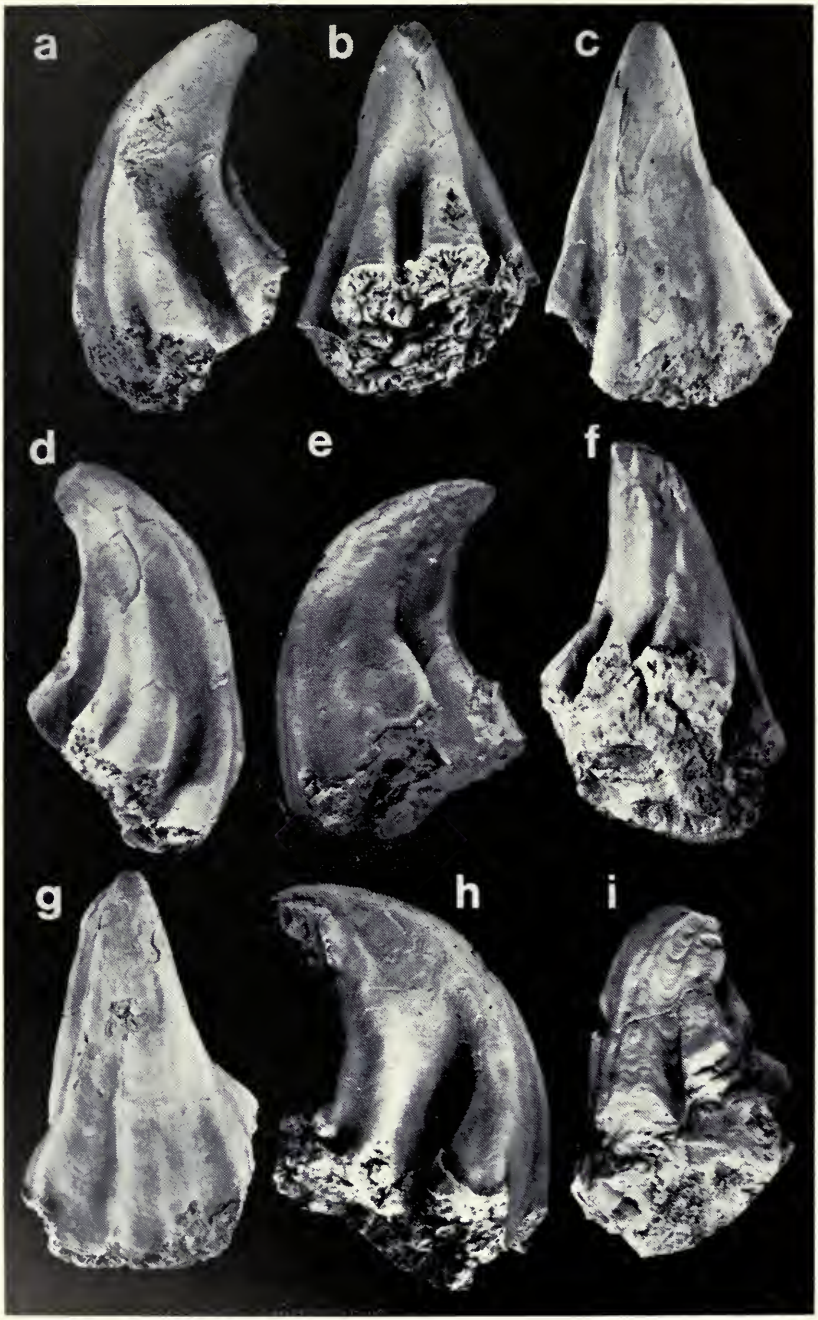
FIG. 54. *Platyceras (Orthonychia) chesterense* Meek and Worthen, 1867, variant 1. **(a)** right lateral view (30364-A); **(b)** anterior view, same specimen; **(c)** left lateral view (26939-A); **(d)** anterior view, same specimen; **(e)** right lateral view, same specimen; **(f)** left lateral view (25095-A); **(g)** left lateral view (30265); **(h)** anterior view, same specimen; **(i)** apertural view, same specimen; **(j)** right lateral view, same specimen; **(k)** apertural view (25095-B); **(l)** left lateral view (26782-A); **(m)** anterior view, same specimen; **(n)** apertural view, same specimen.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pentagonal. The average shell is typically larger than the other variants.

Platyceras pettisense S. A. Miller, 1891 (p. 81, pl. 14, fig. 1) from Burlington Limestone in Missouri, and *Platyceras formosum* Keyes, 1888, (figured by Bowsher, 1955, p. 3, pl. 2, fig. 5) from the Lower Mississippian of Iowa are similar to this variant.

Material, stratigraphic positions, and localities.—Sixteen specimens from six localities, including two "types" of *Platyceras (Orthonychia) chesterense* Meek and Worthen, 1867. Holotype X-157 and X-10522, probably Golconda Limestone, Locality 40; two specimens FMNH UC 26959a, Renault Limestone, Locality 10; one specimen FMNH UC 30640, Paint Creek Shale, Locality 41; nine specimens FMNH UC 30353, Glen Dean Limestone, Locality 12; one specimen FMNH UC 30233a, Golconda Limestone, Locality 18; and one specimen FMNH UC 30808, Renault Limestone, Locality 37.

VARIANT 3. Figures 57, 59.

This variant is typical of *Platyceras (O.) chesterense sensu stricto.* It has five well-defined salients alternating with re-entrants. The anterior side of the shell bears a relatively broadened and well-defined re-entrant, which contrasts to that of Variant 2 where there is a broadened salient.

Material, stratigraphic positions, and localities.—Twenty-five specimens from seven localities. One specimen FMNH UC 30266, Golconda Limestone, Locality 42; four specimens FMNH UC 30233, Golconda Limestone, Locality 18; three specimens FMNH UC 25254 and one specimen FMNH UC 25251, Lower Okaw (Golconda) Limestone, Locality 30; six specimens FMNH UC 25173, Lower Okaw (Marigold Oolite), Locality 14; six specimens FMNH UC 31037, Glen Dean Limestone, Locality 15; three specimens FMNH UC 25096, Lower Okaw Limestone, Locality 11; and one specimen FMNH UC 25326a, Lower Okaw Limestone, Locality 2.

VARIANT 4. Figures 58–59.

This variant resembles Variant 3, but the shell is much compressed laterally and the salients are weak on some. This type of

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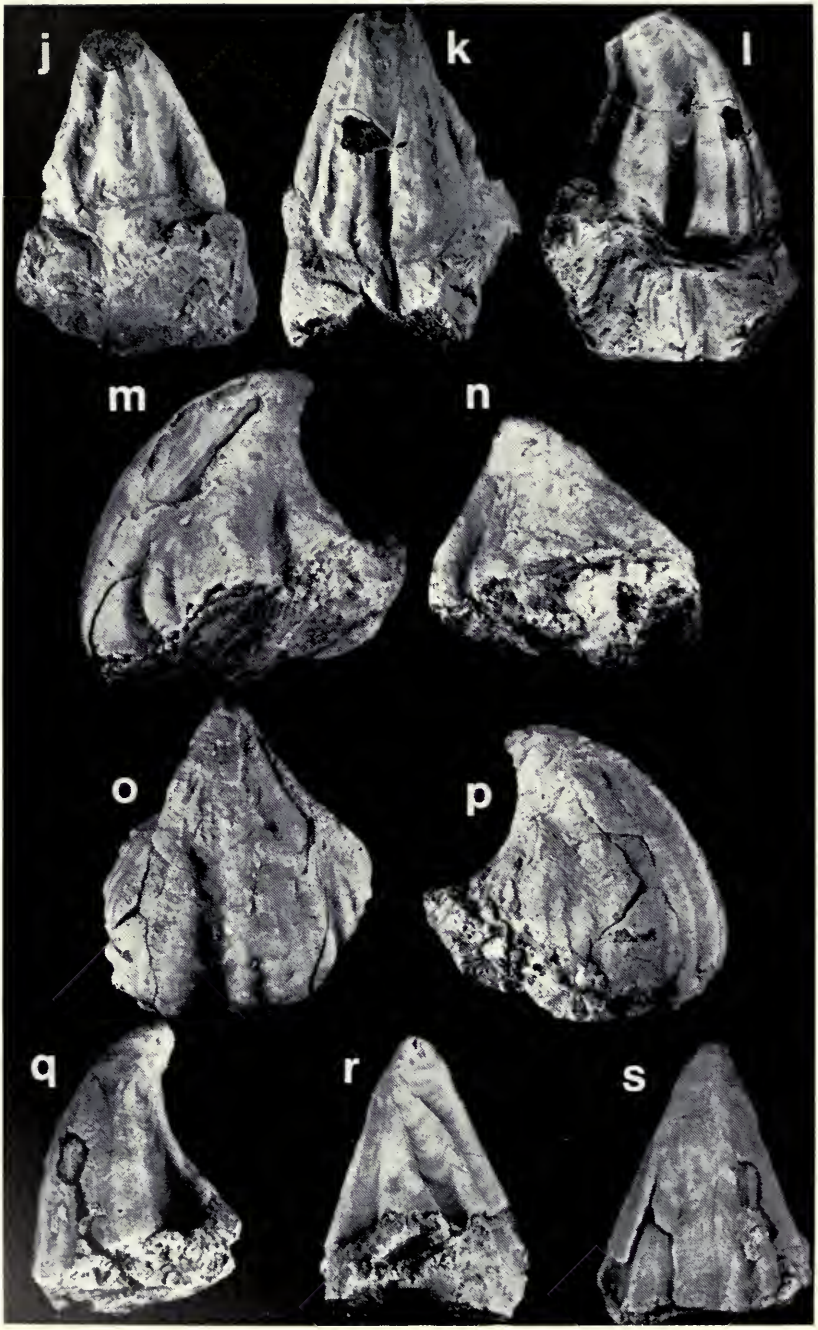
FIG. 55. *Platyceras (Orthonychia) chesterense* Meek and Worthen, 1867, variant 2. **(a)** left lateral view (30353-A); **(b)** apertural view, same specimen; **(c)** anterior view, same specimen; **(d)** right lateral view, same specimen; **(e)** left lateral view (30353-B); **(f)** apertural view, same specimen; **(g)** anterior view, same specimen; **(h)** right lateral view, same specimen; **(i)** left lateral view (30233a). All FMNH UC. All × 2.5.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shell may have grown attached to the side of a *Pentremites* with the aperture covering an ambulacral area and some portion of the adjoining radials, resulting in its elongated shape.

Material, stratigraphic positions, and localities.—Five specimens from three localities. One specimen FMNH UC 25144, Lower Okaw (Golconda) Limestone, Locality 17; two specimens FMNH UC 26940, Paint Creek Shale, Locality 34; two specimens FMNH UC 26736, Glen Dean Limestone, Locality 43.

Evolutionary Trends

The stratigraphic distribution of these variants suggests an evolutionary trend (fig. 59). Variant 1 appeared in the Renault Formation at the base of the Chester Series. Its characters, such as smooth and round form and delayed development of the five salients, are believed to be primitive. Variability was great at this stage. Some individuals show the beginning of a strong dorsal salient (fig. 53a, b, f, k, o) and others have features which could later develop into Variants 3 or 4. The trend which gave rise to Variant 2 began in Renault time; though few specimens of this kind are found in this formation. Variants 3 and 4 appeared during Paint Creek time. Although this radiant occurred during Lower Chester (Gasparian) time, all forms persisted and flourished through the Middle Chester (Hombergian) age.

Genus **Strophostylus** Hall, 1859

Type species.—*Strophostylus andrewsi* Hall, 1860, subsequently designated by Keyes (1890b, p. 1,113).

Definition.—Naticiform, with few whorls, large aperture and twisted spiral columellar plate. Spire small; whorls rapidly expanding; usually anomphalous. Aperture large with its columellar lip twisted and parietal lip with or without very thin inductural deposition.

Stratigraphic range.—? Silurian, Lower Devonian, Mississippian to Pennsylvanian, ? Permian.

Fig. 55, *Continued.*—*Platyceras* (*Orthonychia*) *chesterense* var. 2. **(j)** apertural view, same specimen; **(k)** anterior view, same specimen; **(l)** right lateral view, same specimen; **(m)** left lateral view (holotype X-157); **(n)** apertural view, same specimen; **(o)** anterior view, same specimen; **(p)** right lateral view, same specimen; **(q)** left lateral view (FMNH UC 30353-C); **(r)** posterior view, same specimen; **(s)** anterior view, same specimen. All × 2.5.

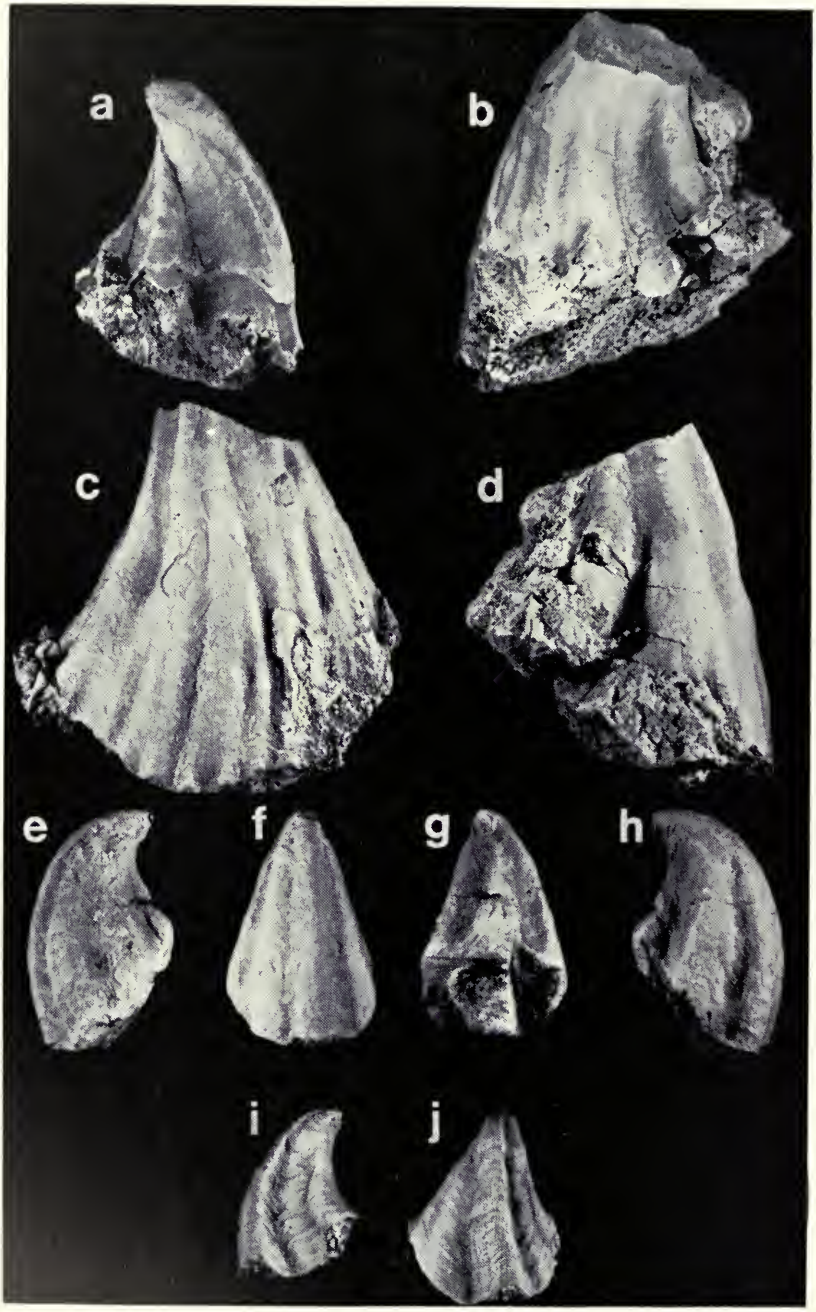
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FIG. 56, *Continued.—Platyceras (Orthonychia) chesterense* Meek and Worthen, 1867, var. 2. **(k)** anterior view (FMNH UC 30353-E); **(l)** apertural view, same specimen; **(m)** right lateral view, same specimen. All × 2.5.

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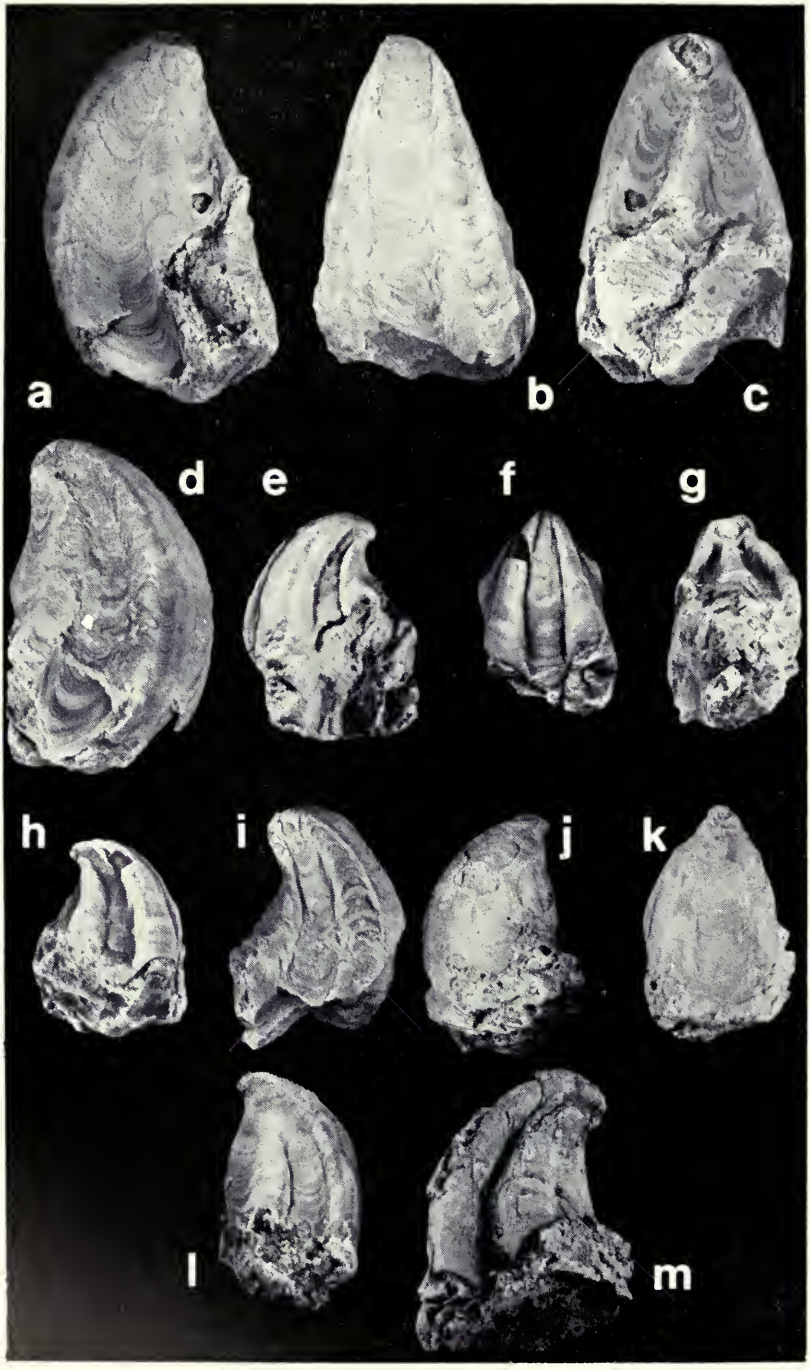
FIG. 56. *Platyceras (Orthonychia) chesterense* Meek and Worthen, 1867, variant 2. **(a)** right lateral view, × 2.5 (30353-C); **(b)** left lateral view, × 2.5 (30353-D); **(c)** anterior view, × 2.5, same specimen; **(d)** right lateral view, × 2.5, same specimen; **(e)** left lateral view, × 3 (30808); **(f)** anterior view, × 3, same specimen; **(g)** apertural view, × 3, same specimen; **(h)** right lateral view, × 3, same specimen; **(i)** left lateral view, × 3 (26959a); **(j)** anterior view, × 3, same specimen. All FMNH UC.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Discussion.—In the past many authors have confused *Naticopsis* and *Strophostylus* because of the lack of important generic distinctions. Knight (1941), however, clarified the genus. *Strophostylus* is characterized by irregularity of form as in the family Platyceratidae, and the presence of a spiral columellar plate. The large and thick pariteal inductura which is characteristic of *Naticopsis* is lacking.

American Upper Mississippian species.—*Strophostylus splendens* Girty, 1915 (1915a, p. 125, pl. 11, figs. 11–12a) from Batesville, Arkansas, and two unnamed species, one reported by Easton (1942, pl. 10, fig. 18) from Pitkin Limestone of northern Arkansas, and the other by Elias (1958, p. 22, pl. 1, figs. 17–19) from the Late Mississippian of southern Oklahoma are referred to this genus.

Strophostylus wortheni (S. Weller, 1916). Figure 60.

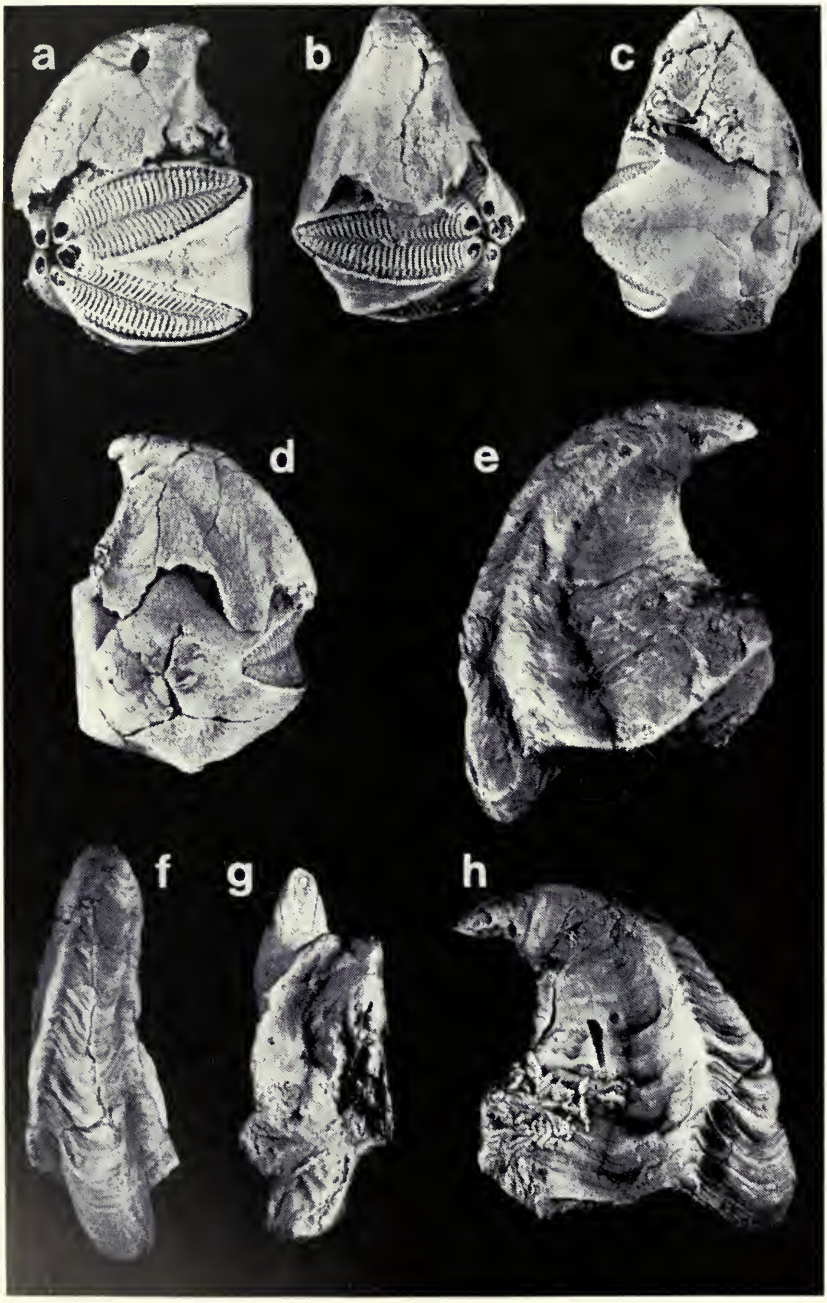
Naticopsis wortheni. S. Weller, 1916, Contr. Walker Mus., **1**, no. 10, p. 259, pl. 19, figs. 1, 2.

Description.—Shells small, naticiform, anomphalous, having about 2½ volutions which increase rapidly in size; height slightly less than width. Spire relatively low, body whorl very large, aperture large, subovate, higher than wide. Whorl profile well arched between sutures; upper surface of final whorl somewhat flattened, strongly arched at middle, less so below. Suture incised, but not deep. Base gently rounded. Columellar lip not well known, but thin, slightly reflexed, and probably twisted. No sign of parietal inductura on the inner lip; outer lip unknown. Ornament absent, except for very weak collabral lirae which slope moderately prosocline on upper surface and less strongly on side and lower surface. Shell thin.

Comparison.—*Strophostylus wortheni* resembles *S. chesterensis* n. sp., but the final whorl of the latter species is more narrowly rounded, and the aperture is relatively wider.

Measurements.—Measurements are given in Table 26.

FIG. 57. *Platyceras* (*Orthonychia*) *chesterense* Meek and Worthen, 1867, variant 3. **(a)** left lateral view (30266); **(b)** anterior view, same specimen; **(c)** posterior view, same specimen; **(d)** right lateral view, same specimen; **(e)** left lateral view (25254-A); **(f)** anterior view, same specimen; **(g)** apertural view, same specimen; **(h)** right lateral view, same specimen; **(i)** right lateral view (25173-2); **(j)** left lateral view (25173-1); **(k)** anterior view, same specimen; **(l)** right lateral view, same specimen; **(m)** left lateral view (25251). All FMNH UC. All × 3.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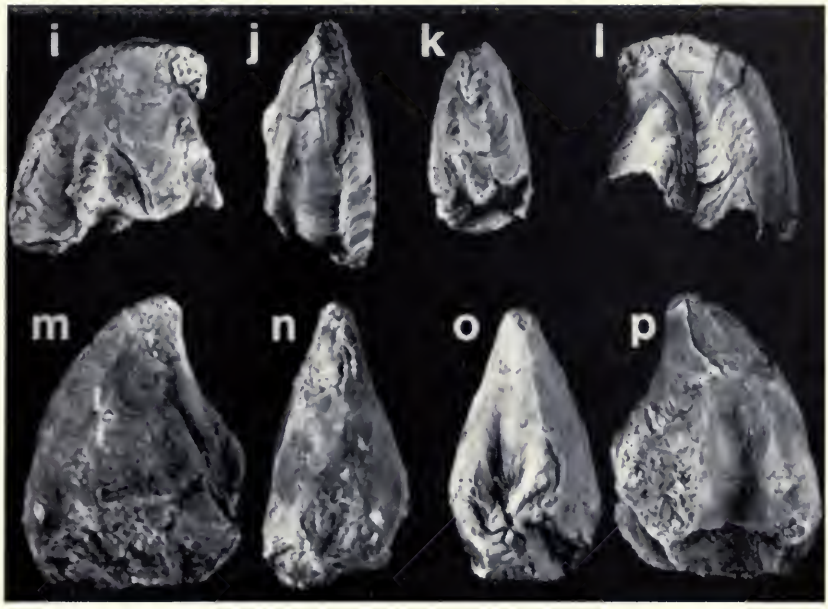

FIG. 58, *Continued.—Platyceras (Orthonychia) chesterense* Meek and Worthen, 1867, var. 4. **(i)** left lateral view (26904-B); **(j)** anterior view, same specimen; **(k)** posterior view, same specimen; **(l)** right lateral view, same specimen; **(m)** left lateral view (26736-A); **(n)** anterior view, same specimen; **(o)** posterior view, same specimen; **(p)** right lateral view, same specimen. All FMNH UC. All × 3.

TABLE 26.—Measurements (in mm.) of *Strophostylus wortheni* (S. Weller, 1916).

Specimen FMNH UC	H	W
25598	6.8	7.4
25122-1	3.4	5.0
25122-2	3.5	4.6
25122-A	2.3	3.4

Material, stratigraphic positions, and localities.—Eleven specimens from four localities. Most are fairly well preserved. Both immature and mature growth stages are represented. Three speci-

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FIG. 58. *Platyceras (Orthonychia) chesterense* Meek and Worthen, 1867, variant 4. **(a)** left lateral view showing attachment to *Pentremites godoni* (25144); **(b)** anterior view, same specimen; **(c)** posterior view, same specimen; **(d)** right lateral view revealing that margin of the shell had followed closely the surface in contact, same specimen; **(e)** left lateral view (26940-A); **(f)** anterior view, same specimen; **(g)** basal view showing outline of aperture, same specimen; **(h)** right lateral same specimen.

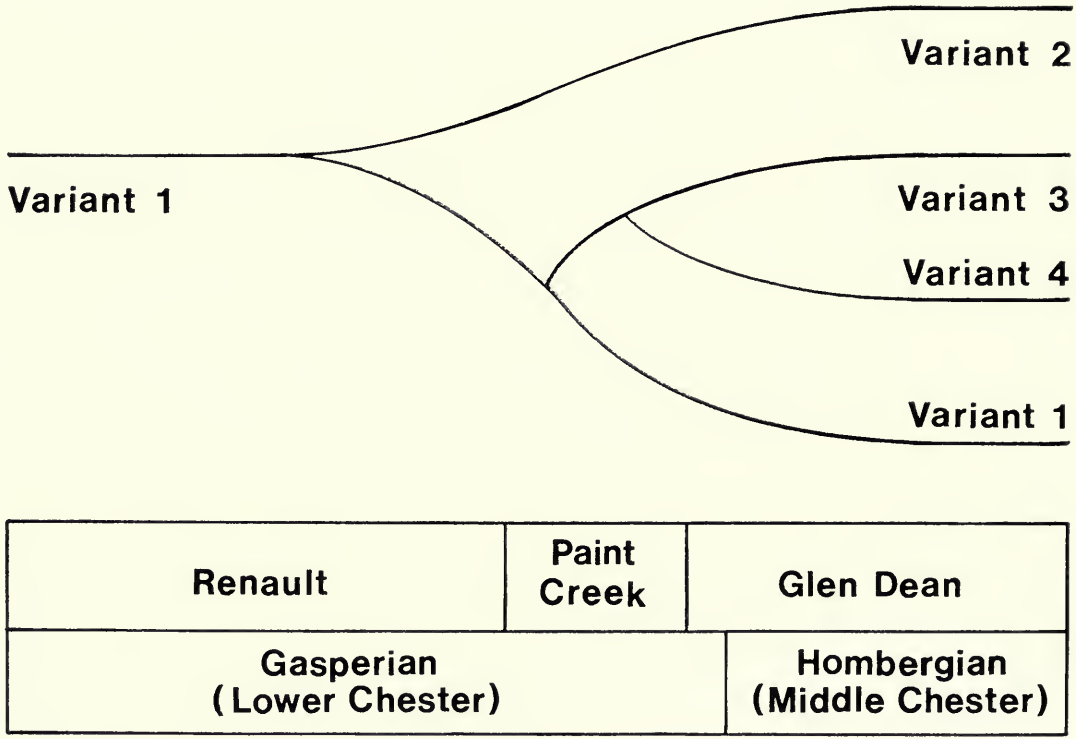


FIG. 59. Phylogeny of variants of *Platyceras* (*Orthonychia*) *chesterense* Meek and Worthen, 1867.

FIG. 60. *Strophostylus wortheni* (S. Weller, 1916). **(a)** dorsal view of holotype from Ste. Genevieve Limestone, × 6 (14864-A); **(b)** apertural view of rather immature specimen, × 10 (25122-A); **(c)** dorsal view, × 10, same specimen; **(d)** apical view, × 10, same specimen; **(e)** apical view, × 6 (14864-A). All FMNH UC.

mens FMNH UC 25122, Lower Okaw (Evansville Oolite), Locality 3; three specimens FMNH UC 25054, Marigold Oolite, Locality 14; and one specimen FMNH UC 25598, Golconda Limestone, Locality 9; holotype FMNH UC 14864-A; and three specimens of *Naticopsis wortheni* S. Weller, 1916, FMNH UC 14864 B-D, Locality 48.

Strophostylus chesterensis n. sp. Figure 61.

Description.—Shells small, naticiform, having about 2½ rapidly increasing volutions, spire relatively low, body whorl large, aperture large and subtransverse, height slightly less than width. Whorl profile well-arched, narrowly rounded between sutures. Upper surface of final whorl very slightly convex, sharply arched at middle, less so below. This whorl embracing the penultimate whorl below periphery. Suture impressed. Base gently rounded, somewhat pseudophaneromphalous. Columellar lip rather thin, slightly reflexed, and probably twisted; parietal lip without inductura. Ornament absent, except for fine collabral lirae, sloping strongly prosocline below upper

suture, more gently on lower surface. Growth lirae occasionally thickened near upper suture and in columellar area. Shell thin.

Comparison.—*Strophostylus chesterensis* differs from *S. splendens* Girty, 1915, by its shorter and more narrowly rounded final whorl.

Measurements (in mm.).—Measurements on the better preserved specimen are: height—4.9; width—5.3; height of aperture—3.1; width of aperture—4.0.

Material, stratigraphic position, and locality.—Two specimens from a single locality. One is almost perfectly preserved. Holotype: FMNH UC 30484 and one specimen FMNH UC 56308, Golconda Limestone, Locality 9.

Suborder Neritopsina Cox and Knight, 1960

Superfamily Neritacea Rafinesque, 1815

Family Neritopsidae Gray, 1847

Subfamily Naticopsinae S. A. Miller, 1886

Genus **Naticopsis** M'Coy, 1846

Type species.—*Naticopsis phillipsii* M'Coy, 1846, subsequently designated by Meek and Worthen, 1866b, p. 364.

Definition.—Shells with moderately high to low spire, relatively very broad. Genus is divisible into intergrading subgenera.

Stratigraphic range.—Middle Devonian to Triassic.

Discussion.—Many species of *Naticopsis* are noted for a remarkable series of ontogenetic changes (Girty, 1912a, p. 338; Knight, 1933a, p. 362). Individuals of different growth stages are quite different, sometimes so different that it is often difficult to recognize two specimens as belonging to the same species if they are not part of a rather complete suite. The species considered here exhibit growth changes of this kind. Only species referable to the typical subgenus have been found among the specimens studied.

Subgenus **Naticopsis** M'Coy, 1846

Type species.—*Naticopsis phillipsii* M'Coy, 1846.

Definition.—Shell globular with a slightly protruding spire. Aperture large, expanded in direction oblique to axis. Parietal and columellar lips moderately thickened, may be crossed by toothlike markings.

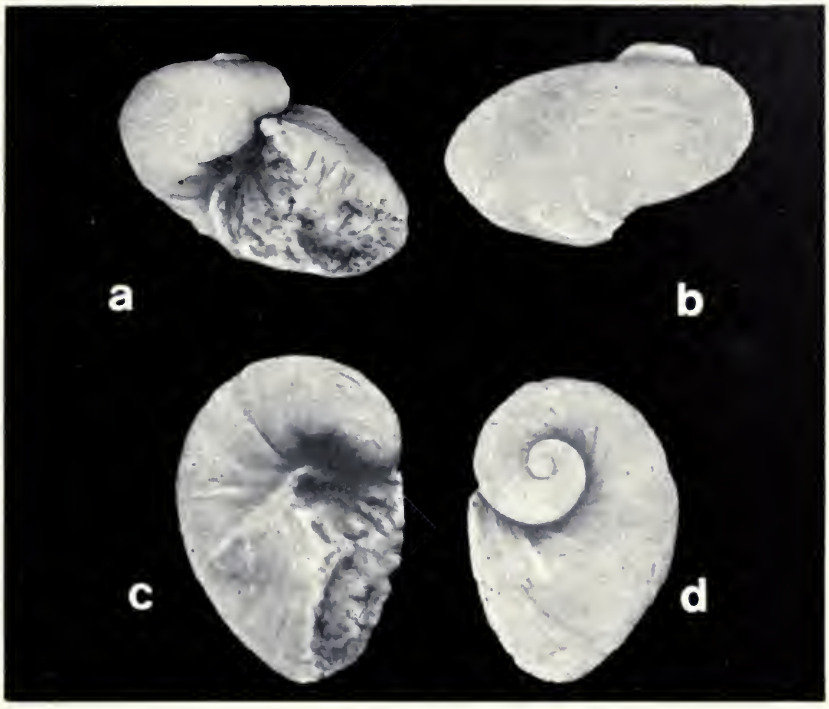


FIG. 61. *Strophostylus chesterensis* n. sp. **(a)** apertural view of holotype (FMNH UC 30484); **(b)** dorsal view, same specimen; **(c)** umbilical view, same specimen; **(d)** apical view, same specimen. All × 6.

Stratigraphic range.—Middle Devonian to Triassic.

American Upper Mississippian species.—The following species which have been reported from formations equivalent to the Chester Series are referred to this subgenus:

Natica carlyana Hall, 1857 (p. 31; see Hall, 1883, pp. 369–370, pl. 31, figs. 26–27).

Naticopsis littonana var. *genevievensis* Meek and Worthen, 1867 (p. 268).

Natica chesterensis Swallow, 1863 (p. 100). Swallow's types are lost.

Naticopsis picta Girty, 1912b (pp. 339–340, pl. 1, figs. 9–11).

Naticopsis remex White, 1876 (see White, 1880a, p. 139, pl. 34, fig. 6a).

Naticopsis (*Naticopsis*) *suturicompta* Yochelson and Dutro, 1960 (pp. 142–143, pl. 14, figs. 20–25).

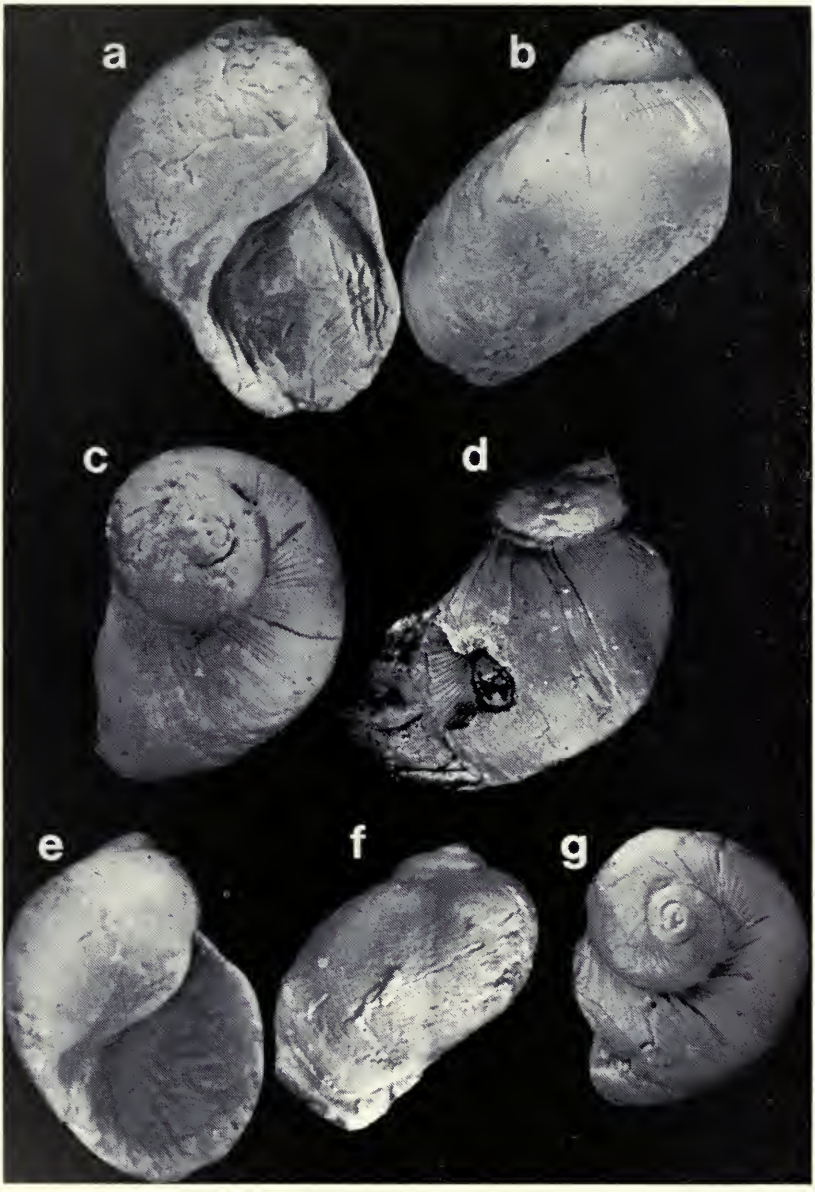


FIG. 62. *Naticopsis* (*Naticopsis*) *mariona* n. sp. **(a)** apertural view of holotype (56309); **(b)** dorsal view, same specimen; **(c)** apical view, same specimen; **(d)** oblique dorsal view (56310-A); **(e)** apertural view (56310-B); **(f)** dorsal view (56310-C); **(g)** apical view, same specimen. All FMNH UC. All × 3.5.

Naticopsis (Naticopsis) mariona new species. Figure 62.

Description.—Medium-size, subglobular, neritopsid shells, with subsutural ornamentation. Protoconch consists of about 1½ smooth rounded whorls, dextral. Body whorl well rounded in neanic and ephebic stages, less so in gerontic stage, embracing the penultimate whorl below the periphery in ephebic specimens. The profile has a narrow subsutural ramp in the ephebic stage, followed by smoothly curved periphery, and a rounded surface below. This ramp disappears at the gerontic stage and the surface above the periphery becomes wider and more gently inclined, but it is sharply rounded at the periphery below it. Spire composed of convex whorls, extremely short in ephebic but less so in gerontic specimens. Suture distinct, becoming more impressed with age. Base rounded and extended anteriorly, anomphalous. Aperture wide, oval, higher than wide. Columellar lip and parietal walls with thickened inductura, crossed in the parietal region of neanic individuals by obliquely transversed rugae. Parietal inductura moderately thickened, arcuate, covering the surface of inner lip and extending beyond it to cover some outside area. Columella rather strongly and sweepingly arcuate. Outer lip sharp and thin, convex from inside view, most convex below. A channel present at the junction of the outer lip with the parietal wall. Ornamented with fine collabral lirae which are strongest on the subsutural ramp in ephebic, or on the area close to the upper suture on gerontic specimens, becoming fainter or almost disappearing on rest of the surface. Growth lirae swinging backward with a broad convexity above and moderately backward on base. Shell thick.

Ontogenetic change.—Ontogenetic development involves conspicuous changes. Nepionic specimens have not been recognized. In the neanic stage, the final whorl is rounded with a relatively short inconspicuous spire. In the early ephebic stage, the spire is more distinct. In the late ephebic stage, the upper surface of the final whorl becomes more prominent with a slight subsutural ramp, but is still well rounded. In the gerontic stage, the last whorl is less rounded and the upper surface slopes more gently and is wider. As a result, the whorl is somewhat longer, the suture is more impressed, the spire is higher, and the pleural angle decreases progressively with age. Another common gerontic development is the appearance of a short vertical surface immediately below the upper suture. Finally, subsutural ornamentation becomes confused with the thicker growth lirae. Change in apertural outline is not conspicuous.

Remarks.—Some of the larger specimens are almost perfect, but their apertures are filled with matrix. Thus, the apertural characters are not clearly exposed, and their description is based on two smaller neanic specimens. The largest specimen is about 24 mm. in height, but it is too poorly preserved to show many of its original characters clearly.

Comparisons.—*Naticopsis* (*Naticopsis*) *mariona* resembles *N.* (*Jedria*) *ventricosa* (Norwood and Pratten, 1855), especially as illustrated by Knight (1933a, p. 372, pl. 41, figs. 2a–j), in ornamentation of the upper whorl slope and similar ontogenetic change. Ephebic specimens, however, have more rounded whorls, and lack the spiral groove on the upper half of the body whorl. Also ephebic specimens of *N.* (*N.*) *mariona* can be distinguished from those of *N.* (*N.*) *suturicompta* Yochelson and Dutro, 1960, (pp. 142–143) by less rounded whorls, and more widely oval aperture. *N.* (*N.*) *mariona* resembles *N.* (*N.*) *carlyana* (Hall), a common Mississippian species, by its more strongly oval aperture.

Measurements.—Measurements are given in Table 27.

TABLE 27.—Measurements (in mm.) of *Naticopsis* (*Naticopsis*) *mariona* n. sp.

Specimen FMNH UC	H	W	Ha	Wa	Pa	H/W	Ha/Wa
56310-B	13.1	9.3	9.6	6.9	89°	1.41	1.39
56309	15.2	10.7	9.8	7.2	82°	1.42	1.36
30552-3	14.6	11.8	9.0	7.5	98°	1.24	1.20

Material, stratigraphic positions, and localities.—Twelve specimens from two localities. Many of them are fairly well preserved, and they exhibit a spectrum of ontogenetic stages, from neanic to gerontic. Holotype FMNH UC 56309, three specimens FMNH UC 56310 and five specimens FMNH 30552, Golconda Limestone, Locality 44; two specimens FMNH UC 30225, Kinkaid Limestone, Locality 45; and one specimen FMNH UC 30224, locality and stratigraphy unknown.

Naticopsis (Naticopsis) suturicompta Yochelson and Dutro, 1960. Figure 63.

Naticopsis (*Naticopsis*) *suturicompta*. Yochelson and Dutro, 1960, U.S. Geol. Surv. Prof. Pap. 334-D, pp. 142–143, pl. 14, figs. 20–25.

Description.—Shell well-rounded, with ornament on a subsutural ramp. Protoconch consists of 1½ rounded whorls. Spire short; body whorl embracing the penultimate whorl just above the periphery.

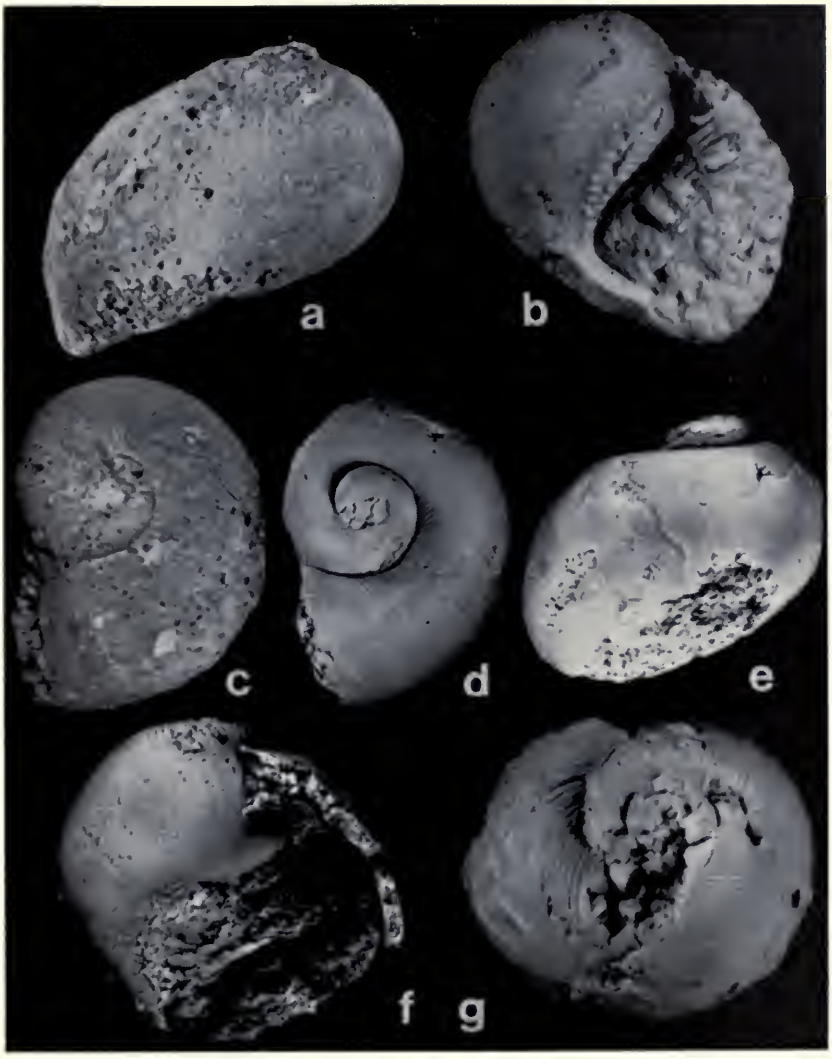


FIG. 63. *Naticopsis* (*Naticopsis*) *suturicompta* Yochelson and Dutro, 1960. **(a)** dorsal view, × 8 (30485-A); **(b)** apertural view, × 8, same specimen; **(c)** apical view, × 8, same specimen; **(d)** apical view, × 3 (25198); **(e)** dorsal view, × 3, same specimen; **(f)** apertural view, × 3 (30885); **(g)** apical view, × 3, same specimen.

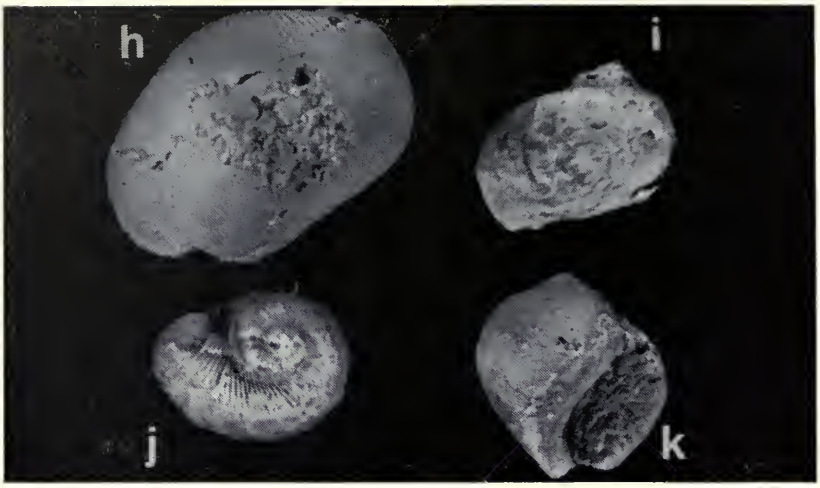


FIG. 63, *Continued.*—*Naticopsis* (*Naticopsis*) *suturicompta* Yochelson and Dutro, 1960. **(h)** dorsal view, × 3, same specimen; **(i)** dorsal view, × 3 (25597); **(j)** apical view, × 3, same specimen; **(k)** apertural view, × 3, same specimen. All FMNH UC.

Sutures distinct, becoming more impressed with age. Whorls relatively well-rounded, apple-shaped with a narrow subsutural ramp in intermediate growth stages, followed by a smooth curve at periphery, and a slight elongation of whorl below. Base rounded obliquely, anomphalous. Aperture subelliptical, higher than wide. Columellar lip arcuate. Columella and parietal walls thickened with inductura which in the parietal region is seemingly crossed obliquely by transversed rugae. Ornament of distinct subsutural collabral lirae which are sharply rounded and appear after the earliest growth stages, occur coincidentally with the development of the subsutural ramp. Growth lines faint, rather straight, and swing gently backward from suture to columella. Shell moderately thick.

Discussion.—The subsutural ornamentation which dies out regularly and abruptly and merges with the regular growth lines suggests *Naticopsis genevievensis* Meek and Worthen, 1867. Identification of the latter species, however, is most dubious. It was first described as *Naticopsis littonana* var. *genevievensis*, but *Naticopsis littonana* Hall, 1856, according to Meek and Worthen is a *Sphaerodoma* (see Girty, 1915b, p. 199). Meek and Worthen's type specimen is very imperfectly preserved (Girty, 1915a, p. 121), and it was never illustrated.

The specimens in the present collection seem to accord perfectly with the description and illustrations of *N.* (*N.*) *suturicompta*. Be-

sides the presence of subsutural ornamentation, the "apple-shaped" body whorl profile, definitely suggests this species. This species differs from *N.* (*N.*) *carlyana* Hall by its subsutural ornamentation.

Measurements.—Measurements are given in Table 28.

TABLE 28.—Measurements (in mm.) of *Naticopsis* (*Naticopsis*) *suturicompta* Yochelson and Dutro, 1960.

Specimen FMNH UC	H	W	Ha	Wa	Pa	Nw	H/W
25198	11.9	11.2	10.5	7.8	123°	3.0+	1.06
30885	14.0+	14.8	13.5	...	....	...	....
25597	8.1	6.7	6.4	4.9	110°	4.5	1.21
30485-A	6.0	4.0	4.9	4.3	135°	3.5	1.50
30485-B	4.3	2.9	3.3	2.5	127°	3.0	1.50

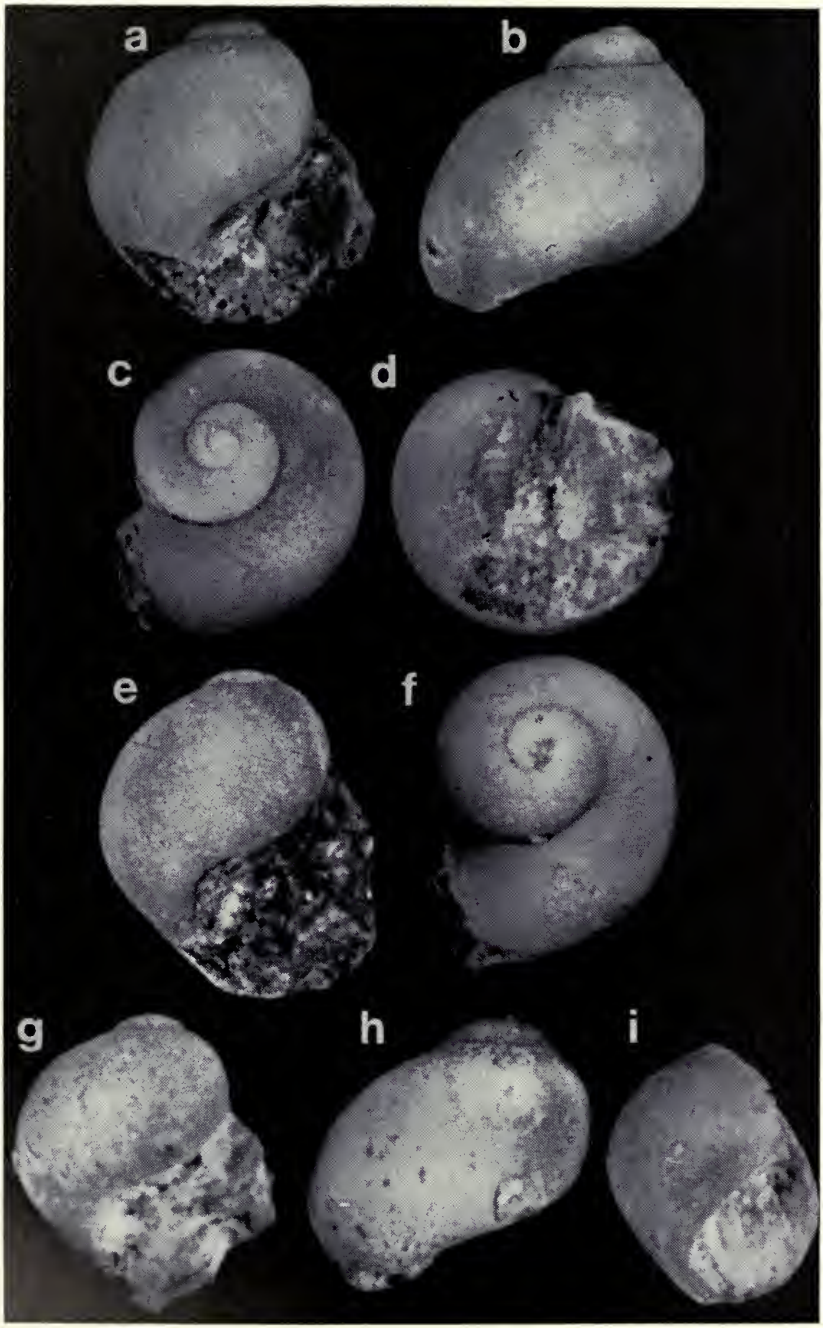
Material, stratigraphic positions, and localities.—Five specimens from three localities. One of them seems to be in the neanic and the others in the ephebic stages of development. Two specimens FMNH UC 30485 and one specimen FMNH UC 25597, Golconda Limestone, Locality 49; one specimen FMNH UC 25198, Lower Okaw (Golconda) Limestone, Locality 46; and one specimen FMNH UC 30885, Glen Dean Limestone, Locality 47.

Naticopsis (Naticopsis) waterlooensis S. Weller, 1916. Figure 64.

Naticopsis waterlooensis. S. Weller, 1916, Contr. Walker Mus., 1, no. 10, pp. 259–260, pl. 19, figs. 3–6.

Description.—Shell very small, with about $2\frac{1}{2}$ to $3\frac{1}{2}$ volutions, smooth, with extremely large body whorl. Spire very short, only slightly elevated, consisting of convex whorls, average pleural angle 109 degrees. Body whorl profile well-rounded in young specimens, but with a subsutural ramp on adult specimens, embracing the penultimate whorl well above periphery. Suture linear, shallow. Base rounded, somewhat oblique, anomphalous. Aperture large, suboval, higher than wide. Columella rather oblique. Parietal and columellar lips covered with thick parietal inductura, crossed in good specimens by transversed rugae. Outer lip thin, sharp, convex, increasingly so below. A well-marked channel formed at the junction of the outer lip with the parietal wall. Ornament absent, shell perfectly smooth, and thick.

Ontogenetic change.—With increasing size the spire becomes relatively shorter and the body whorl relatively larger. The last whorl also becomes more sharply rounded and develops a subsutural ramp.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i

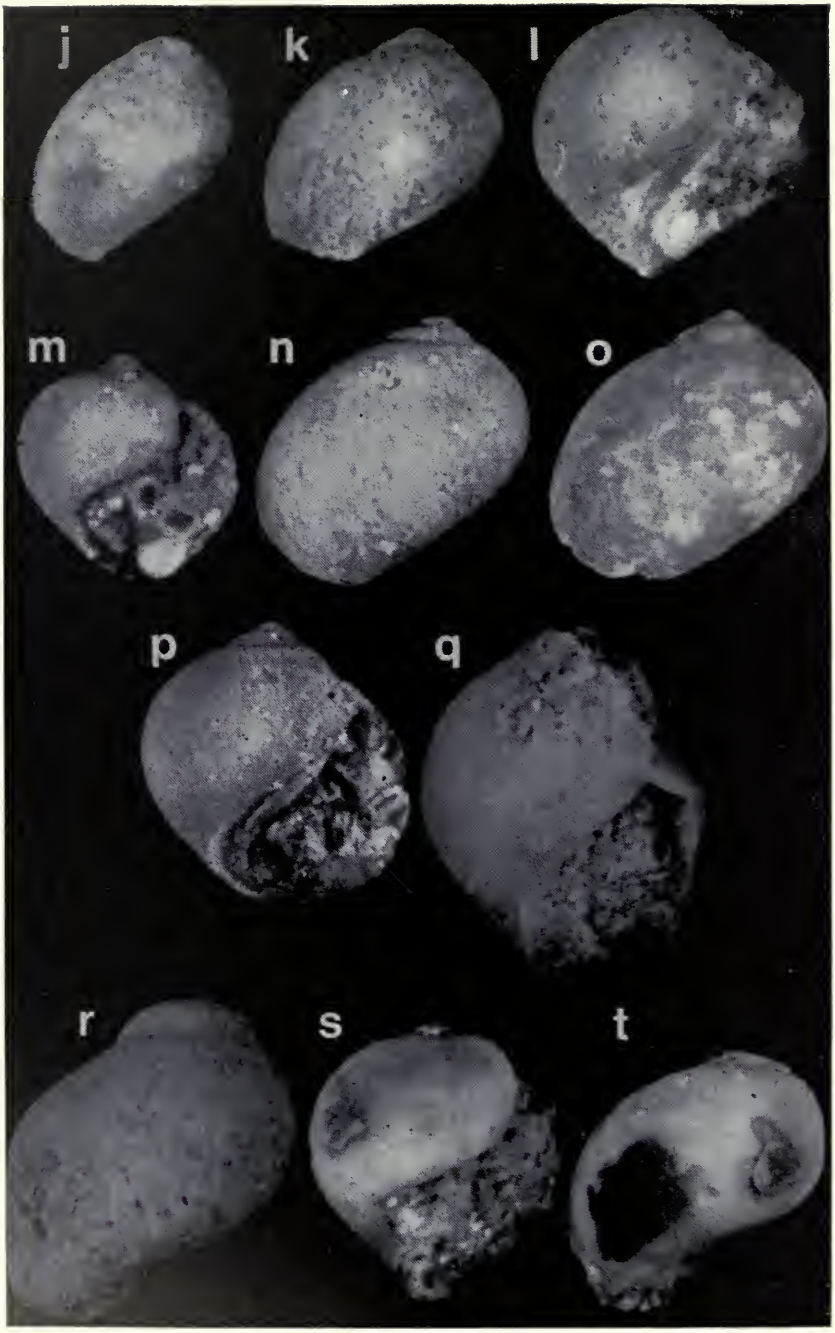
Comparison.—*Naticopsis* (*Naticopsis*) *waterlooensis* closely resembles *Strophostylus splendens* Girty, 1915 (p. 125, pl. 11, figs. 11–12a), but it is much smaller, globose, and without ornamentation.

TABLE 29.—Measurements (in mm.) of *Naticopsis* (*Naticopsis*) *waterlooensis* S. Weller, 1916.

Specimen FMNH UC	H	W	Ha	Wa	Pa	Nw	H/W
25118-A	3.5	3.2	...	...	96°	3.0	...
25118-B	3.0	2.3	...	...	99°	3.0	...
25057-B	3.2	3.0	...	...	107°	2.5	...
25057-2	3.0	2.0	...	...	91°	...	...
25057-3	2.8	1.9	...	...	106°	3.0	...
25057-4	2.7	1.9	...	...	95°	2.5	...
25057-5	2.3	1.5	...	...	96°	2.5	...
25057-A	2.5	2.0	...	...	98°	2.5	...
25057-7	3.3	2.7	...	...	114°	3.5	...
25057-8	3.2	2.7	2.3	2.1	120°	3.5	...
25020-A	3.6	3.6	2.2	1.9	92°	3.0	...
25020-B	2.9	2.8	1.9	1.6	93°	3.0	...
25020-3	3.0	1.9	...	...	92°	...	...
25020-4	2.5	1.7	...	...	95°	..	...
25020-5	2.1	1.4	...	...	105°	3.0	...
25020-6	2.2	1.4	1.3	1.2	101°	2.5	...
25020-7	2.0	1.3	...	...	77°	3.0	...
25020-8	2.3	1.6	...	...	103°	2.5	...
25020-9	2.5	2.0	...	...	106°	...	...
25020-10	2.6	1.9	...	...	99°	2.5	...
25020-11	2.8	2.7	1.9	1.6	121°	3.5	...
25020-12	2.9	2.2	...	...	111°	3.5	...
25020-13	2.4	1.9	...	...	111°	3.5	...
25020-14	2.3	1.9	...	...	120°	...	...
25020-15	1.7	1.4	...	...	140°	2.5	...
25020-16	1.9	1.4	...	...	111°	2.5	...
25041-A	2.8	2.8	1.9	1.7	116°	3.5	...
25041-B	2.7	2.6	1.8	1.6	128°	3.5	...
25041-3	2.6	1.8	1.7	1.5	114°	...	...
25041-4	2.4	1.7	...	...	125°	3.5	...
25041-5	2.4	1.7	...	...	111°	3.5	...
25041-6	2.3	1.8	...	...	126°	3.5	...
25181-1	3.4	2.8	...	...	134°	...	...
25181-2	2.4	1.9	...	...	130°	3.5	...
25181-A	2.0	1.9	...	...	124°	3.5	...
25181-4	1.9	1.5	...	...	125°	3.5	...
Total	94.1	69.2	...	...	3932	...	...
Mean	2.6	1.9	...	...	109	...	...
S.D.	0.469	0.406	...	...	3.52	...	...
S.E. (m)	0.079	0.069	...	...	0.60	...	...

Corr. coeff. between H and W = + 0.92

FIG. 64. *Naticopsis* (*Naticopsis*) *waterlooensis* S. Weller, 1916. **(a)** apertural view, × 12 (25118-A); **(b)** dorsal view, × 12, same specimen; **(c)** apical view, × 12, same specimen; **(d)** umbilical view showing thickened columellar lip with tooth-like markings, × 12, same specimen; **(e)** apertural view, × 12 (25020-A); **(f)** apical view, × 12, same specimen; **(g)** apertural view, × 12 (25020-B); **(h)** dorsal view, × 12, same specimen; **(i)** apertural view, × 12 (25118-B).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Measurements.—Measurements are given in Table 29.

Material, stratigraphic positions, and localities.—Fifty-two specimens from four localities in Illinois. All Chester specimens came from the Lower Okaw or equivalent Golconda Limestone. Although all specimens are very small, they are believed to include those representing mature stages of development. Three original specimens of Stuart Weller FMNH UC 14865, (holotype: FMNH UC 14865-A) Ste. Genevieve Limestone, Locality 48; two specimens FMNH UC 25118 and four specimens FMNH UC 25181, Lower Okaw (Evansville Oolite), Locality 3; twenty-six specimens FMNH UC 25020, Lower Okaw Limestone, Locality 49; nine specimens FMNH UC 25057 and eight specimens FMNH UC 25041, Lower Okaw (Marigold Oolite), Locality 14.

Naticopsis (Naticopsis) sp. indet. Figure 65.

Description.—Shell globose, spire very short, final whorl large and sharply rounded. Parietal and columellar lips with a thick inductura.

Discussion.—This form differs from *N.* (*N.*) *mariona* n. sp. by its globose form, and from *N.* (*N.*) *suturicompta* by being more globose, with a less sharply rounded final whorl, and shorter spire. Greatest width about 18 mm.

Material, stratigraphic position, and locality.—Four imperfect specimens FMNH UC 30346 from Glen Dean Limestone, Locality 12.

Order ?Archaeogastropoda Thiele, 1925

Suborder Murchisoniina Cox and Knight, 1960

Superfamily Murchisoniacea Koken, 1896

Family Murchisoniidae Koken, 1896

Genus **Aclisina** deKoninck, 1881

Type species.—*Murchisonia striatula* deKoninck, 1843.

FIG. 64, *Continued.*—*Naticopsis* (*Naticopsis*) *waterlooensis* S. Weller, 1916. **(j)** dorsal view, × 12 (25057-A); **(k)** dorsal view, × 12 (25057-B); **(l)** apertural view × 12, same specimen; **(m)** apertural view, × 15 (25181-A); **(n)** dorsal view, × 14 (25041-A); **(o)** dorsal view, × 14 (25041-B); **(p)** apertural view, × 14, same specimen; **(q)** apertural view of Weller's holotype × 10 (14865-A); **(r)** dorsal view, × 10, same specimen; **(s)** apertural view of another "type" of Weller, × 12 (14861-B); **(t)** dorsal view, × 12, same specimen. All FMNH UC.

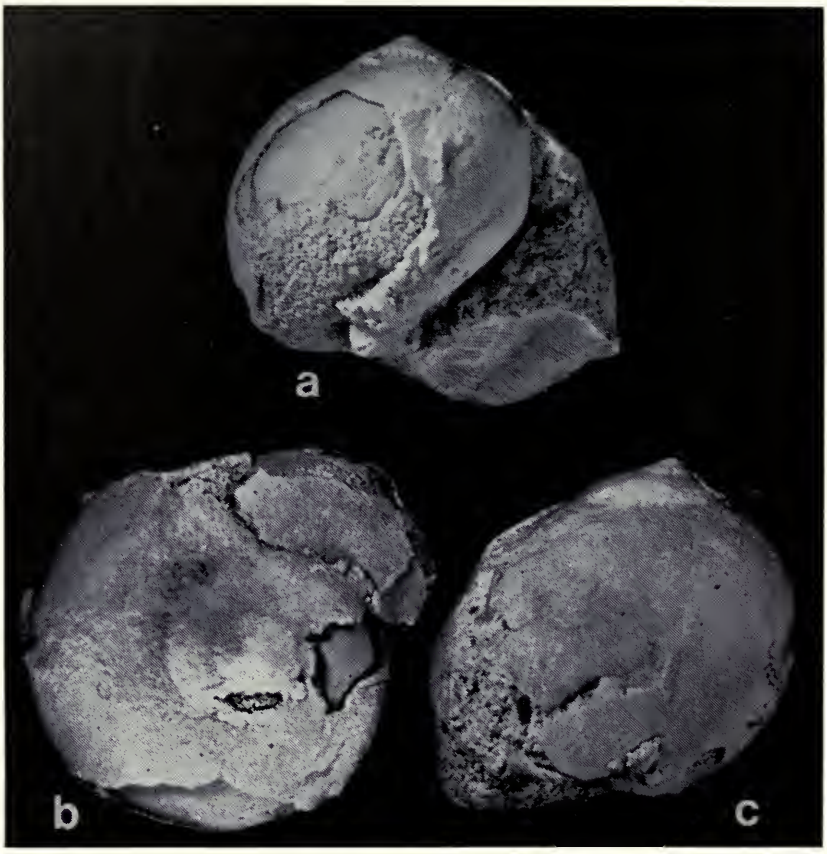


FIG. 65. *Naticopsis (Naticopsis)* sp. indet. **(a)** apertural view (FMNH UC 30346-A); **(b)** apical view, same specimen; **(c)** dorsal view, same specimen. All × 3.

Definition.—High-spired shells with many whorls, numerous revolving costae, a short slit, and a peripheral selenizone. Base rounded, anomphalous. Nucleus unknown. Columellar lip reflexed, very gently arcuate. Parietal inductura thin, but well developed. Outer lip slightly convex, meeting columellar lip to form an incipient inhalant siphon. Sinus deep and angular, culminating in a slit, about one-fifth of the whorl circumference in depth which gives rise to an obscure selenizone. Growth lines exceedingly faint, swinging moderately backward above selenizone, convexly forward below it. Ornament consists of a series of strong spiral costae, three of them are rather crowded on the selenizone.

Stratigraphic range.—Mississippian to Pennsylvanian.

American Carboniferous species.—Of all species previously described as *Aclisina* from the Carboniferous formations of the United States, only one, *Aclisina swallowiana* (Geinitz, 1866) (p. 5, pl. 1, fig. 19), a Pennsylvanian species from Nebraska, seems properly to belong to this genus. Most of the other species probably should be assigned to *Donaldina* Knight, 1933. New forms, *Aclisina golconda* and *A. marvinwelleri*, present in our collections, are valid Mississippian representatives.

Aclisina golconda n. sp. Figure 66.

Description.—Shell high-spired, rather attenuated, consisting of about ten volutions. Whorl profile between sutures moderately rounded, but slope above periphery steeper than that below it in adult whorls; earlier whorls more evenly rounded. Protoconch orthostrophic, composed of 2½ smooth, rounded whorls. Sutures rather deep, well impressed. Base sharply rounded, somewhat extended. Aperture subcircular, but slightly higher than wide. Columellar lip thin, slightly arcuate. Parietal inductura unknown. Slit deep, rather narrow, giving rise to an obscure selenizone. Ornament con-

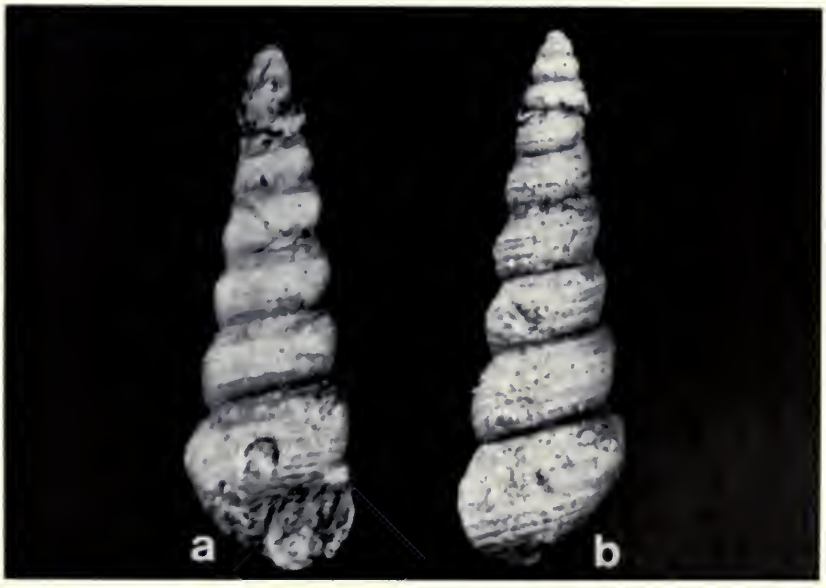


FIG. 66. *Aclisina golconda* n. sp. **(a)** apertural view of holotype (FMNH UC 56345); **(b)** dorsal view, same specimen. All × 4.

sists of a series of rather strong spiral costae, mostly thicker than interspaces; two strong ones and an intermediate weaker one at the periphery mark the selenizone. Two slightly weaker costae located above the selenizone, and two others, about as strong as those of the periphery, occupy the space between the selenizone and lower suture. About seven costae resembling those above, occupy the basal surface. Growth lines exceedingly fine, swinging slightly backward above selenizone, slightly forward below it to the columellar lip.

Ontogeny.—Protoconch consists of about 2½ whorls which are smooth and without spiral ornament, although faint growth lines on the second whorl probably marked this as the nepionic stage. Two peripheral spiral costae appear on the third whorl and full ornament is complete on the fifth whorl. The lateral profile is evenly rounded up to the sixth whorl where the ephebic stage is reached. Adulthood was attained at the completion of the seventh whorl where the slope above the periphery becomes steeper than that below. Senility seems to be indicated by the somewhat diffuseness of the spiral ornament and the introduction of thin spiral lirae inserted between the stronger costae. This begins with the appearance of a thin thread between the lower border of selenizone and the costa immediately below it, on the ninth and tenth whorls.

Comparison.—*Aclisina golconda* somewhat resembles *Aclisina striatula* (deKoninck, 1843) which was redescribed by Donald (1898, pp. 67–68, pl. 5, figs. 6–8; Longstaff, 1918, pp. 78–81, pl. 6, figs. 10–15; Knight, 1941, pp. 30–31, pl. 44, figs. 3a–d). A close comparison reveals, however, that the whorls of the new species are more sharply rounded, and the shell is more slender with less inclined growth lines. It differs from *A. swallowiana* (Geinitz, 1866) by being more attenuated and having less sharply rounded whorls.

Measurements.—Measurements are given in Table 30.

TABLE 30.—Measurements (in mm.) of *Aclisina golconda* n. sp.

Specimen FMNH UC	H	W	Hs	Hf	Ha	Wa	Pa	Nw	H/W	Hs/Hf
56345	15.0	4.6	9.1	5.9	2.6	2.4	12°	10	3.3	1.54
56346	4.4+	2.3	...	...	1.9	...	12°	5+	...	....

Material, stratigraphic position, and locality.—Three specimens from a single locality. One is fairly well preserved although broken, and repaired. A second is immature with some of its earlier whorls missing. The third is part of an adult individual, consisting of only two whorls. Holotype: FMNH UC 56345 and two specimens FMNH UC 56346, Golconda Limestone, Locality 9.

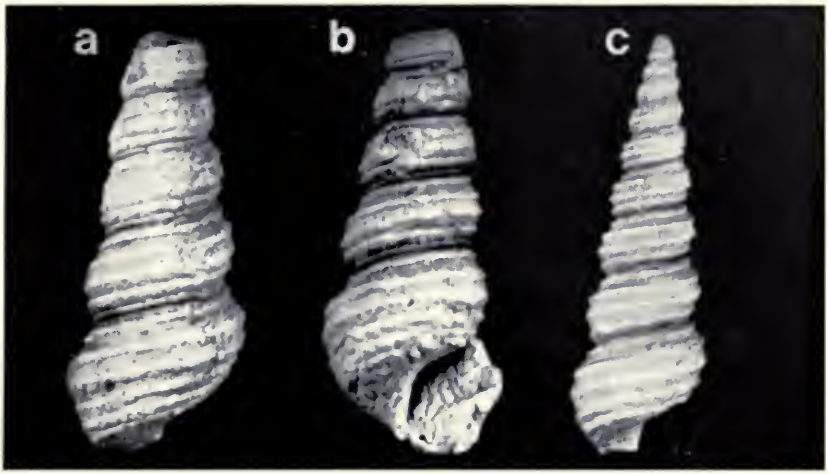


FIG. 67. *Aclisina marvinwelleri* n. sp. **(a)** dorsal view of holotype (56347); **(b)** apertural view, same specimen; **(c)** dorsal view (25958). All FMNH UC. All × 4.

Aclisina marvinwelleri new species. Figures 67–68.

Description.—Shell quite attenuated with 10½ volutions. Whorls between deep, well-impressed sutures, evenly and strongly rounded with earlier whorls rounded more evenly than later ones. Protoconch consists of about 1½ smooth whorls. Base flatly rounded. Slit apparently quite shallow, attaining about sixteenth of the circumference. Ornament consisting of four strong spiral carinae and one weaker spiral lira. Two of the strong carinae and the weak lira mark the selenizone at the middle of the whorl. Two carinae as strong as those above occupy the space between selenizone

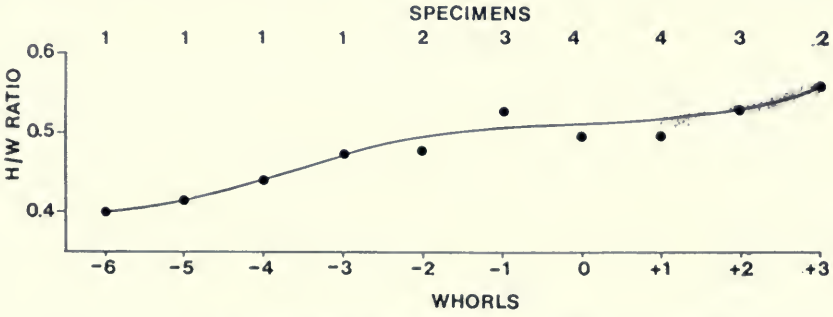


FIG. 68. Curve showing average height to width ratio of four specimens of *Aclisina marvinwelleri* n. sp.

and lower suture. Two more carinae occur in the base of the last whorl. Growth lines exceedingly faint, swinging moderately prosocline above selenizone, curving back gently on selenizone, and swinging slightly forward below it.

TABLE 31.—Measurements (in mm.) of *Aclisina marvinwelleri* n. sp.

Specimen FMNH UC	H	W	Hs	Hf	Ha	Wa	Pa	Nw	H/W	Hs/Hf
25958	11.1	3.4	6.9	4.2	2.0	...	15°	10.5	3.3	1.64
56347	11.0+	4.8	...	...	2.8	2.7	15°	5.0+	...	....
30491-2	7.9+	3.3	...	...	1.9	1.6	15°	5.0+	...	....
25029	6.1+	2.5	...	...	...	...	17°	5.0+	...	....

Ontogeny.—Protoconch consists of about 1½ smooth, rounded whorls. Diffused peripheral ornament marking the selenizone appears on the next whorl, giving it a sharply rounded appearance. Another costa begins below the upper suture on the fourth whorl. The fourth costa becomes evident on the fifth whorl above the lower suture. The weak lira at the middle of the selenizone is present on the seventh whorl. The spiral ornament is weak and whorls are rather smoothly rounded before the sixth whorl, indicating juvenility. On the sixth whorl, the carinae are angular and well differentiated. This whorl is distinctively larger than the preceding one suggesting the attainment of early maturity. Later whorls differ only by having sharper and higher carinae. The average ontogenetic growth curve is shown in Figure 68 and indicates that some individuals reached senility. The low sigmoidal curve probably reveals relatively slow development of the neanic and ephebic stages.

TABLE 32.—Measurements (in mm.) of each whorl of *Aclisina marvinwelleri* n. sp.

Specimen FMNH UC		Whorl No.									
		−6	−5	−4	−3	−2	−1	0	+1	+2	+3
	H	0.20	0.27	0.40	0.48	0.60	0.88	1.00	1.30	1.50	1.90
25958	W	0.50	0.65	0.90	1.00	1.20	1.60	1.90	2.40	2.90	3.30
	H/W	0.40	0.42	0.44	0.48	0.50	0.55	0.53	0.54	0.52	0.58
	H	....	....	....	....	....	....	1.00	1.30	1.60	2.00
56347	W	....	....	....	....	....	....	2.30	2.80	3.10	3.80
	H/W	....	....	....	....	....	....	0.43	0.46	0.52	0.53
	H	....	....	....	....	....	0.90	1.00	1.35	2.65	....
30491-2	W	....	....	....	....	....	1.75	2.00	2.65	3.00	....
	H/W	....	....	....	....	....	0.51	0.50	0.51	0.53	....
	H	....	....	....	....	0.60	0.83	1.00	1.10	....	....
25029	W	....	....	....	....	1.30	1.58	1.90	2.20	....	....
	H/W	....	....	....	....	0.46	0.53	0.53	0.50	....	....
N	H/W	1	1	1	1	2	3	4	4	3	2
Total	H/W	0.40	0.42	0.44	0.48	0.96	1.59	1.99	2.01	1.58	1.11
Mean	H/W	0.40	0.42	0.44	0.48	0.48	0.53	0.50	0.50	0.53	0.56

Comparisons.—This species differs from *Aclisina striatula* (de-Koninck, 1843) by having fewer and more angular carinae, and deeper sutures. It differs from *A. swallowiana* (Geinitz, 1866) by its different pattern of ornamentation. It differs from *A. golconda* n. sp. by having stronger ornament, deeper sutures, and more convex whorls.

Measurements.—Measurements are given in Tables 31 and 32.

Materials, stratigraphic positions, and localities.—Five specimens from three localities. One is quite perfectly preserved. Holotype FMNH UC 56347 and two specimens FMNH UC 30491, Golconda Limestone, Locality 9; one specimen FMNH UC 25958, Golconda Limestone, Locality 50; one specimen FMNH UC 25029, Lower Okaw (Marigold Oolite), Locality 14.

Genus **Stegocoelia** Donald, 1889

Type species.—*Murchisonia* (*Stegocoelia*) *compacta* Donald, 1889.

Definition.—Shells with spiral threads or carinae; short slit and selenizone above periphery; shape variable which is the basis for differentiating intergrading subgenera.

Stratigraphic range.—Mississippian to Middle Permian.

Subgenus **Stegocoelia** Donald, 1889

Type species.—*Murchisonia* (*Stegocoelia*) *compacta* Donald, 1889.

Definition.—Shells with relatively low spire; whorls commonly rounded, although very slightly angular; inner lip reflected on the columella; parietal inductura thin, but well developed.

Stratigraphic range.—Mississippian to Pennsylvanian.

American Carboniferous species.—The following Carboniferous species are referrable to this subgenus:

Solenospira illinoiensis S. Weller, 1916 (pp. 256–257, pl. 18, figs. 21–23), Ste. Genevieve Limestone, Illinois.

Murchisonia inornata Meek and Worthen, 1867 (see Meek and Worthen, 1873, pp. 599–600, pl. 28, fig. 6), Pennsylvanian of Illinois.

Stegocoelia (Stegocoelia) kentuckiensis new species. Figures 69–70.

Description.—Shell relatively obtuse, with nine volutions, final whorl constitutes more than half of the entire height. Whorl profile between sutures somewhat narrowly rounded, but form distorted by strong spiral cords. Sutures deep and well impressed. Base rounded,

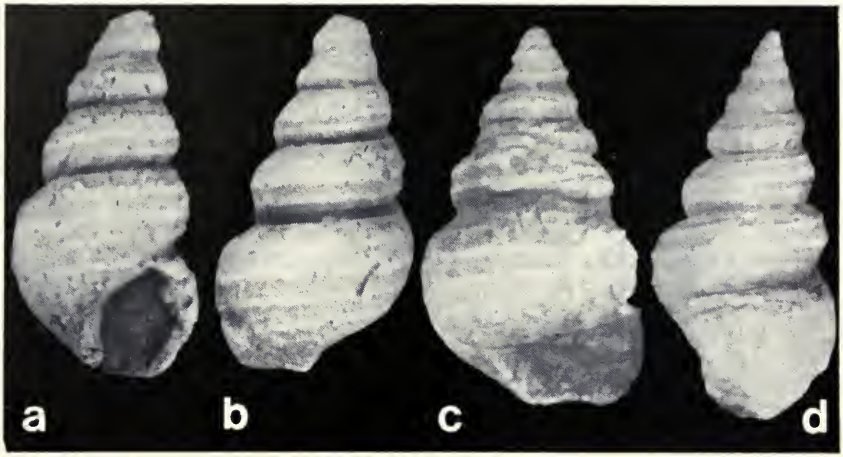


FIG. 69. *Stegocoelia (Stegocoelia) kentuckiensis* n. sp. **(a)** apertural view of holotype (56348); **(b)** dorsal view, same specimen; **(c)** apertural view of laterally compressed specimen (56349); **(d)** anterior dorsal view, same specimen. All FMNH UC. All × 7.

anomphalous. Aperture suboval, higher than wide. Columellar lip thickened, slightly arcuate. Outer lip convex laterally, seemingly with a slight channel anteriorly. Slit apparently very shallow and wide which gave rise to an obscure selenizone, occupying space between uppermost and second cord. Ornament consisting of two pairs of spiral cords between sutures on the whorls. The upper pair bounds the selenizone. The upper third is situated at about the periphery, and the lowest is midway between it and the lower suture. About three more spiral cords occur below on the base of the last whorl. Very fine growth lines swing slightly backward above the selenizone, forward below it to the lower suture, and then change to a backward swing on base. Shell slightly thickened.

Ontogeny.—The protoconch consists of about three smooth, rounded whorls with gently prosocline growth lines representing the nepionic stage. The lower pair of spiral cords appears on the fourth whorl which is still rounded. One of the cords of the upper pair is introduced near the upper suture of the fifth or sixth whorl, and as the lower cords are becoming stronger, the whorls become more angular, and asymmetrical in lateral profile. This represents the neanic stage. The last cord appears near the upper suture on the seventh whorl, and the spiral ornament is complete. This seems to indicate the attainment of maturity. The growth curve for this species is shown in Figure 70.

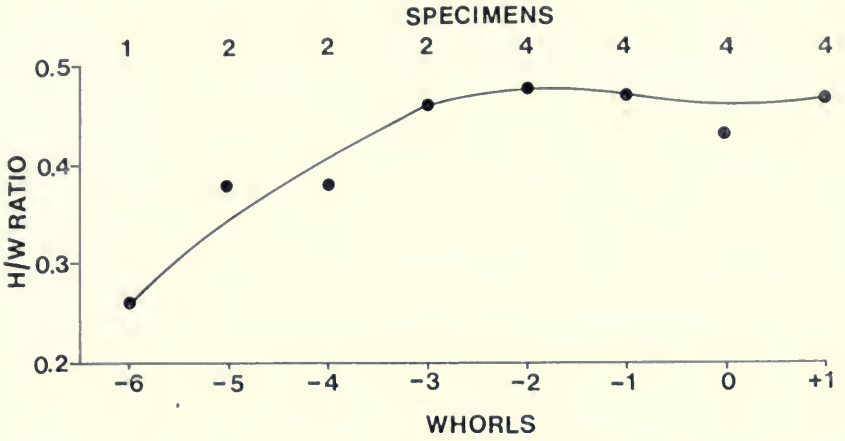


FIG. 70. Curve showing average height to width ratio of four specimens of *Stegocoelia* (*Stegocoelia*) *kentuckiensis* n. sp.

TABLE 33.—Measurements (in mm.) of *Stegocoelia* (*Stegocoelia*) *kentuckiensis* n. sp.

Specimen FMNH UC	H	W	Hs	Hf	Ha	Wa	Pa	Nw	H/W	Hs/Hf
30492-1	7.2	3.7+	3.3	3.9	...	...	33°	9	...	....
56348	6.9	4.1	3.2	3.7	...	...	34°	9	1.7	0.86
30492-3	6.7+	3.6	...	...	2.0	1.7	28°	6+	...	....
56349	6.8+	3.3	...	...	...	...	..	5+	...	....

TABLE 34.—Measurements (in mm.) of each whorl of *Stegocoelia* (*Stegocoelia*) *kentuckiensis* n. sp.

Specimen FMNH UC		Whorl No.							
		—6	—5	—4	—3	—2	—1	0	+1
30492-1	H	....	0.19	0.25	0.40	0.57	0.80	1.00	1.30
	W	....	0.45	0.65	0.92	1.19	1.66	2.22	2.96
	H/W	....	0.42	0.38	0.43	0.48	0.48	0.45	0.44
56349	H	0.90	0.19	0.30	0.50	0.60	0 81	1.00	1.50
	W	0.35	0.56	0.80	1.05	1.50	2.04	2.76	3.65
	H/W	0.26	0.34	0.38	0.48	0.40	0.40	0.36	0.41
30492-3	H	....	....	....	....	0.62	0.80	1.00	1.50
	W	....	....	....	....	1.03	1.57	2.15	2.80
	H/W	....	....	....	....	0.60	0.51	0.47	0.54
56348	H	....	....	....	....	0.50	0.85	1.00	1.50
	W	....	....	....	....	1.20	1.80	2.40	3.05
	H/W	....	....	....	....	0.42	0.47	0.42	0.49
N	H/W	1	2	2	2	4	4	4	4
Total	H/W	0.26	0.76	0.76	0.91	1.90	1.86	1.70	1.88
Mean	H/W	0.26	0.38	0.38	0.46	0.48	0.47	0.43	0.47

Comparison.—This species closely resembles *Stegocoelia* (*Stegocoelia*) *illinoisensis* (S. Weller, 1916) in general form, but comparison reveals that the selenizone is situated relatively higher, the spiral cords are stronger and the sutures are less impressed. This species resembles *S.* (*S.*) *compacta* Donald, 1889 (p. 624, pl. 20, figs. 9–13), a Scottish Lower Carboniferous species, but that species has less rounded whorls, and columellar lip slants outward. This species also resembles *Cyclozyga mirabilis* Knight, 1930 (pp. 74–95, pl. 5, fig. 7), but differs by its type of growth lines, which in *Cyclozyga* extend obliquely downward and backward without any trace of a sinus.

Measurements.—Measurements are given in Tables 33 and 34.

Material, stratigraphic position, and locality.—Seven specimens from a single locality. Except for one, they are more or less compressed laterally. Holotype: FMNH UC 56348, one specimen FMNH UC 56349, five specimens FMNH UC 30492, Golconda Limestone, Locality 9.

Stegocoelia (Stegocoelia) okawensis new species. Figures 4–6, 71.

Description.—Shell composed of about seven volutions. Final whorl commonly slightly shorter than preceding spire. Whorl profile between sutures rounded, more sharply below but rather oblique, and slightly concave between each pair of spiral cords. Sutures well-impressed. Base rounded, anomphalous. Protoconch consists of three

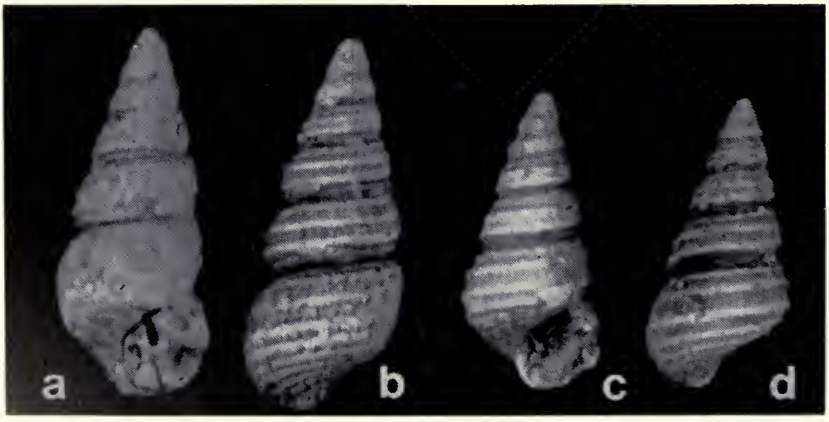


FIG. 71. *Stegocoelia* (*Stegocoelia*) *okawensis* n. sp. **(a)** apertural view of holotype, × 9 (25131); **(b)** dorsal view, × 9, same specimen; **(c)** apertural view, × 10 (25102); **(d)** dorsal view, × 10, same specimen. All FMNH UC.

TABLE 35.—Measurements (in mm.) of *Stegocoelia* (*Stegocoelia*) *okawensis* n. sp.

Specimen FMNH UC	H	W	Hs	Hf	Ha	Wa	Pa	Nw	H/W	Hs/Hf
25131	5.6	2.3	2.9	2.7	1.6	1.2	14°	7.5	2.4	1.1
25021-1	4.1+	1.9	...	...	...	...	18°	6.0+	...	...
25021-2	3.9	1.8	1.9	2.0	1.1	1.0	24°	7.5	2.2	1.0
25021-3	3.5	1.7	1.8	1.7	...	...	25°	7.5	2.1	1.1
25021-4	3.5+	1.8	...	...	1.1	0.9	22°	6.0	...	...
25021-5	3.1	1.7	1.7	1.4	...	...	28°	7.5	1.8	1.2
25021-6	3.0+	1.6	...	...	1.0	0.8	25°	5.0+	...	...
25021-7	2.6	1.3	1.2	1.4	...	...	31°	6.5	2.0	0.9
56350-A	4.5+	2.0	...	...	...	...	25°	7.0+	...	...
56350-B	3.4+	1.6	...	...	...	...	25°	7.0+	...	...
25102	3.9+	1.9	...	...	0.9	0.9	18°	7.0+	...	...

smooth, unornamented whorls. Aperture oval, higher than wide. Columellar lip nearly straight and reflexed. Outer lip with slight angulations both anteriorly and posteriorly. Slit seemingly shallow. Selenizone obscure between the two uppermost cords. Ornament consisting of four spiral cords, the two middle ones being stronger than those above and below; base bearing three to five weaker spiral cords. Growth lines very faint, swinging moderately backward above selenizone, forward between it and lower suture, and backward on the base. Shell moderately thick.

Ontogeny.—Younger shells are more obtuse than older ones. At maturity, they have a longer base and more slender form. The average ontogenetic growth curve in Figure 6 indicates slow growth in juvenile stages, rapid in early maturity, and slow again when maturity was reached.

Comparisons.—*Stegocoelia* (*Stegocoelia*) *okawensis* n. sp. is very similar to *S.* (*S.*) *illinoisensis* (S. Weller, 1916) in form of shell, type of ornamentation, and nature of selenizone. These species might easily be confused if a collection including both adult and immature forms were not available for study. Comparison shows that both species have a tendency to start with an obtuse form, and then become more slender at maturity. The latter species, however, is more obtuse at comparable growth stages. A less reliable differentiating character of some individuals of *S.* (*S.*) *illinoisensis* is the presence of an additional weaker spiral cord at about midway between the selenizone and upper suture. If such a cord is present on individuals of *S.* (*S.*) *okawensis*, it is closer to the upper suture.

This species differs from *S.* (*S.*) *kentuckiensis* n. sp. by its more slender form, less sharply rounded whorls, and a weaker ornamentation.

TABLE 36.—Measurements (in mm.) of each whorl of *Stegocoelia (Stegocoelia) okawensis* n. sp.

Specimen FMNH UC		Whorl No.							
		−4	−3	−2	−1	0	+1	+2	+3
	H	....	....	0.25	0.30	0.50	0.60	0.85	1.00
25131	W	....	....	0.50	0.80	1.00	1.30	1.70	2.00
	H/W	....	....	0.50	0.38	0.50	0.46	0.50	0.50
	H	....	0.10	0.25	0.30	0.50	0.70	....	....
25021-1	W	....	0.45	0.55	0.85	1.00	1.40	....	....
	H/W	....	0.22	0.45	0.35	0.55	0.55	....	....
	H	....	....	....	0.35	0.50	0.70	0.90	....
25021-2	W	....	....	....	0.85	1.00	1.40	1.85	....
	H/W	....	....	....	0.41	0.50	0.50	0.49	....
	H	....	0.10	0.15	0.30	0.50	0.75	....	....
25021-3	W	....	0.40	0.60	0.80	1.00	1.30	....	....
	H/W	....	0.25	0.25	0.38	0.50	0.58	....	....
	H	....	....	0.20	0.37	0.50	0.75	....	....
25021-4	W	....	....	0.60	0.80	1.00	1.40	....	....
	H/W	....	....	0.33	0.46	0.50	0.54	....	....
	H	0.03	0.10	0.20	0.30	0.50	....	....	....
25021-5	W	0.30	0.50	0.60	0.80	1.00	....	....	....
	H/W	0.10	0.20	0.33	0.38	0.50	....	....	....
	H	....	....	....	0.33	0.50	0.70	....	....
25021-6	W	....	....	....	0.90	1.11	1.45	....	....
	H/W	....	....	....	0.37	0.45	0.48	....	....
	H	0.10	0.15	0.20	0.30	0.50	....	....	....
25051-7	W	0.31	0.42	0.60	0.80	1.00	....	....	....
	H/W	0.33	0.36	0.33	0.38	0.50	....	....	....
	H	0.10	0.15	0.20	0.30	0.50	....	....	....
25051-8	W	0.30	0.40	0.60	0.80	1.00	....	....	....
	H/W	0.33	0.38	0.33	0.38	0.50	....	....	....
	H	....	....	0.30	0.40	0.50	0.75	0.90	....
56350-A	W	....	....	0.65	0.80	1.00	1.40	1.80	....
	H/W	....	....	0.46	0.50	0.50	0.54	0.50	....
	H	....	....	0.32	0.40	0.50	0.75	....	....
56350-B	W	....	....	0.70	0.90	1.10	1.40	....	....
	H/W	....	....	0.46	0.44	0.45	0.54	....	....
	H	....	....	0.22	0.30	0.50	0.65	0.98	....
25102	W	....	....	0.54	0.75	0.98	1.30	1.70	....
	H/W	....	....	0.41	0.40	0.51	0.50	0.58	....
N	H/W	3	5	10	12	12	9	4	1
Total	H/W	0.76	1.41	3.85	4.83	5.91	4.69	2.07	0.50
Mean	H/W	0.25	0.28	0.39	0.40	0.49	0.52	0.52	0.50

Measurements.—Measurements are given in Tables 35 and 36.

Material, stratigraphic positions, and localities.—Thirteen specimens from three localities, mostly fairly well-preserved. Holotype FMNH UC 25131 and one specimen FMNH UC 25102, Lower Okaw (Evansville Oolite), Locality 3; eight specimens FMNH UC 25021, Okaw Limestone, Locality 49; and three specimens FMNH UC 56350 Lower Okaw (Marigold Oolite), Locality 14.

Subgenus **Hypergonia** Donald, 1892

Type species.—*Murchisonia quadricarinata* M'Coy, 1844.

Definition.—Shell relatively slender, turriculate with numerous angular whorls, ornamented with carinae; inner lip not reflected on the columellar.

Stratigraphic range.—Mississippian to Pennsylvanian.

American Carboniferous species.—Two Middle Mississippian species, viz., *Murchisonia turritella* Hall, 1857 (p. 27; see Hall, 1883, pp. 361–362, pl. 32, fig. 12), from Salem Limestone of Indiana, and *Loxonema vincta* Hall, 1857, (pp. 28–29; see Hall, 1883, p. 363, pl. 32, fig. 14), from the same locality, and the Pennsylvanian species, *Stegocoelia wortheni* Knight, 1942, p. 488 (former *Loxonema quadricarinatus* Worthen, 1884, p. 7; Worthen, 1890, p. 140, pl. 23, figs. 9–9a) are referred to this subgenus.

Stegocoelia (Hypergonia) baldwinensis new species. Figures 72–73.

Description.—Turritelliform shell consisting of about 11 volutions. Whorl profile between sutures subangular resulting from the presence of a pair of carinae, the upper one a little above mid-height. The general surface between them is vertical and concave. Both above and below these, carinal surface slopes steeply toward the

FIG. 72. *Stegocoelia (Hypergonia) baldwinensis* n. sp. **(a)** dorsal view, × 7 (56353); **(b)** oblique apertural view, × 7, same specimen; **(c)** apertural view of holotype, × 9 (56352); **(d)** dorsal view, × 9, same specimen; **(e)** apertural view, × 9 (25117-A). All FMNH UC.

sutures, which are deeply incised. Base set off by an angulation above. Below this the surface is nearly flat and slopes gently toward the columella. Anomphalous. Protoconch seemingly composed of two smooth and rounded whorls. Aperture subcircular. Columellar lip thin, slightly arcuate. Parietal lip with a thin inductura. Outer lip thin, not forming an angulation posteriorly, slightly convex on outer side, rather flat anteriorly. Slit seemingly very shallow. Selenizone obscure between the upper carina already mentioned and another somewhat weaker one above. Ornament consisting of the three spiral carinae previously described and a fourth one at the basal angulation. Growth lines are very faint, swinging backward above selenizone, forward between selenizone and lower suture, and then backward to columellar lip. Shell seemingly thin, structure unknown.

Ontogeny.—Detailed ontogenetic history cannot be given as apex of the shells is mostly missing. Immature shells are more obtuse than mature ones, and their whorl profile is less angular. Growth curve (fig. 73) of this species shows rapid growth during juvenile and early mature stages which slowed at late maturity.

Comparisons.—*Stegocoelia* (*Hypergonia*) *baldwinensis* n. sp. most closely resembles *S.* (*H.*) *wortheni* Knight, 1942, but it is more slender, whorls are more angular, and sutures are more impressed. It differs from *S.* (*H.*) *vincta* (Hall, 1857), by having a more flattened base.

Measurements.—Measurements are given in Tables 37 and 38.

Material, stratigraphic position, and locality.—Thirteen specimens from one locality. Most are fairly well-preserved although variable portions are missing. Holotype FMNH UC 56352, one specimen FMNH UC 56353, seven specimens FMNH UC 25117, two specimens FMNH UC 25126, two specimens FMNH UC 25101, Lower Okaw (Evansville Oolite), Locality 3.

TABLE 37.—Measurements (in mm.) of *Stegocoelia* (*Hypergonia*) *baldwinensis* n. sp.

Specimen FMNH UC	H	W	Hs	Hf	Ha	Wa	Pa	Nw	H/W	Hs/Hf
25177-1	6.8	2.3	4.6	2.2	1.0	1.1	17°	11	2.96	2.10
25177-2	5.0+	1.9	...	...	1.0	0.9	15°	9+	....	....
25177-3	4.7+	1.9	...	...	...	...	16°	6+	....	....
25177-4	4.9	1.9	3.0	1.6	...	...	15°	9	2.70	1.88
56352	5.0	2.0	3.1	1.9	...	...	17°	9.5	2.50	1.60
25126	3.9+	1.7	...	...	0.9	0.7	19°	7+	....	....
56353	7.5+	3.1	...	...	...	...	14°	6+	....	....
25101	5.9+	2.2	...	...	1.1	1.0	15°	9+	....	....

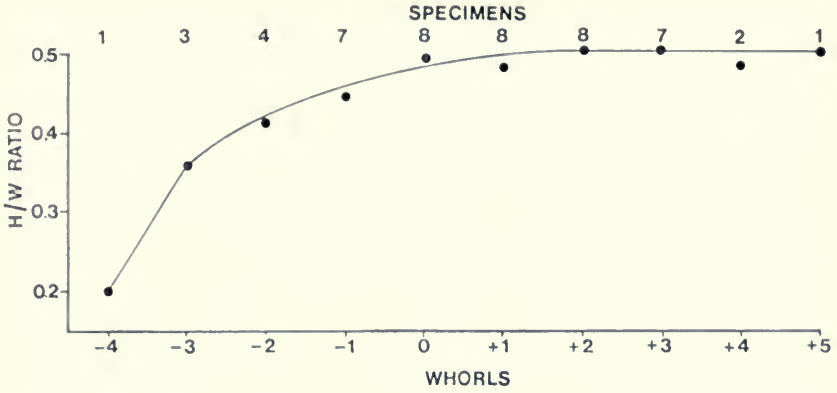


FIG. 73. Curve showing average height to width ratio of eight specimens of *Stegocoelia (Hypergonia) baldwinensis* n. sp.

TABLE 38.—Measurements (in mm.) of each whorl of *Stegocoelia (Hypergonia) baldwinensis* n. sp.

Specimen FMNH UC		Whorl No.									
		−4	−3	−2	−1	0	+1	+2	+3	+4	+5
	H	0.12	0.20	0.30	0.37	0.50	0.60	0.72	0.80	0.85	....
25117-1	W	0.60	0.70	0.85	0.90	1.00	1.24	1.42	1.70	1.90	....
	H/W	0.20	0.29	0.35	0.41	0.50	0.48	0.51	0.47	0.45	....
	H	....	....	....	0.40	0.50	0.60	0.70	0.80	....	....
25117-2	W	....	....	....	0.92	1.20	1.30	1.50	1.70	....	....
	H/W	....	....	....	0.43	0.42	0.46	0.47	0.47	....	....
	H	....	....	....	....	0.50	0.60	0.72	0.85	....	....
25117-3	W	....	....	....	....	1.05	1.30	1.50	1.70	....	....
	H/W	....	....	....	....	0.48	0.46	0.48	0.50	....	....
	H	....	0.25	0.30	0.40	0.50	0.60	0.70	0.80	....	....
25117-A	W	....	0.60	0.73	0.90	1.00	1.20	1.40	1.60	....	....
	H/W	....	0.42	0.41	0.44	0.50	0.50	0.50	0.50	....	....
	H	....	0.20	0.30	0.40	0.50	0.55	0.72	0.90	....	....
56352	W	....	0.55	0.70	0.90	1.00	1.30	1.54	1.80	....	....
	H/W	....	0.36	0.43	0.44	0.50	0.42	0.48	0.50	....	....
	H	....	....	0.30	0.40	0.50	0.65	0.75	....	....	....
25126	W	....	....	0.70	0.85	1.00	1.25	1.50	....	....	....
	H/W	....	....	0.43	0.47	0.50	0.52	0.50	....	....	....
	H	....	....	....	0.40	0.50	0.60	0.75	0.90	....	....
25126-3	W	....	....	....	0.90	1.00	1.20	1.40	1.65	....	....
	H/W	....	....	....	0.44	0.50	0.50	0.54	0.55	....	....
	H	....	....	....	0.40	0.50	0.60	0.70	0.80	0.95	1.00
25101	W	....	....	....	0.90	1.00	1.20	1.40	1.60	1.86	2.00
	H/W	....	....	....	0.44	0.50	0.50	0.50	0.50	0.51	0.50
N	H/W	1	3	4	7	8	8	8	7	2	1
Total	H/W	0.20	1.07	1.62	3.07	3.90	3.84	3.98	3.49	0.96	0.50
Mean	H/W	0.20	0.36	0.41	0.44	0.49	0.48	0.50	0.50	0.48	0.50

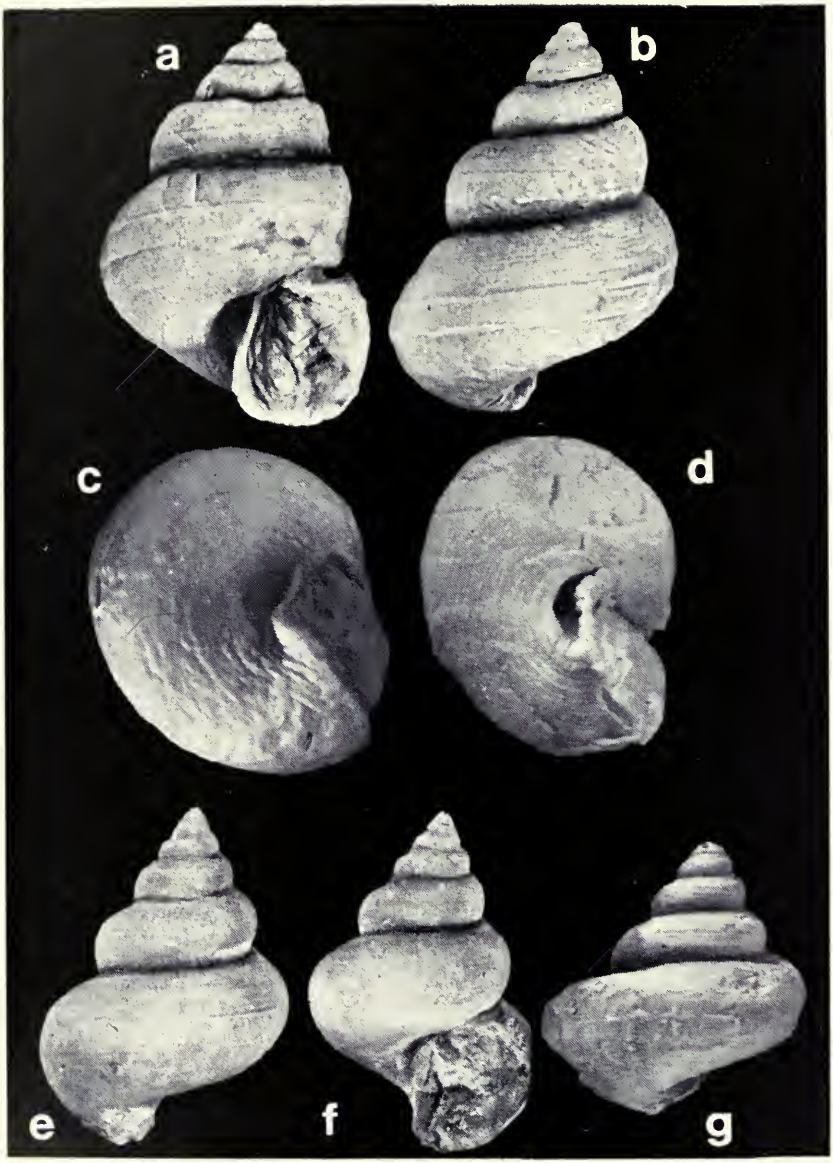


FIG. 74. *Platyzona americana* n. sp. **(a)** apertural view of holotype, × 3 (56354); **(b)** dorsal view, × 3, same specimen; **(c)** umbilical view, × 3, same specimen; **(d)** umbilical view showing basal ornaments and narrow umbilicus, × 4 (56355-A); (e) dorsal view, × 3 (56355-B); **(f)** apertural view, × 3, same specimen; (g) dorsal view of a somewhat crushed specimen, × 4 (56355-C).

FIG. 74. *Continued.—Platyzona americana* n. sp. **(h)** apertural view, × 5 (56355-D); **(i)** dorsal view, × 4 (56355-E); **(j)** section, × 4 (30488-A). All FMNH UC.

Family Plethospiridae Wenz, 1938

Subfamily Pithodeinae Wenz, 1938

Genus **Platyzona** Knight, 1945

Type species.—Pleurotomaria trilineata Hall, 1858.

Definition.—Moderately high-spired to turbiniform with rounded whorls, deep sutures, and a broad flat selenizone well exposed on spire at about periphery. Ornament dominantly spiral lirae which commonly are separated by faint grooves into three groups on base; collabral growth lines very faint, if present; columellar lip thin, reflexed about the narrow umbilicus; anterior channel suggested.

Stratigraphic range.—Devonian to Middle Permian.

American Carboniferous species.—Pleurotomaria broadheadi White, 1880 (see 1880a, p. 169, pl. 42, figs. 1a, b) from Upper Pennsylvanian of Missouri; *Pleurotomaria arkansana* Girty, 1915 (1915a, p. 113, pl. 11, figs. 8, 8a) from Batesville Sandstone, Arkansas; *Pleurotomaria trilineata* Hall, 1857 (p. 25; 1883, pp. 357–358, pl. 32, fig. 20), from Salem Limestone of Indiana; and an indeterminate species *Platyzona* sp. by Yochelson and Dutro, 1960 (p. 144, pl. 14, fig. 2) from ?Upper Mississippian of Northern Alaska are referred to this genus.

Platyzona americana new species. Figure 74.

Description.—Shells with evenly rounded only slightly embracing whorls, very narrowly phaneromphalous to anomphalous. Largest individual a little less than half as high as wide. Selenizone located

centrally on whorl, about one-fourth as wide as whorl is high. Ornament subdued, consisting of low rounded revolving lirae; those bounding selenizone most prominent; 12 or more on upper whorl surface, a little more widely spaced and stronger in central part of lower whorl surface. Growth lines indistinct except on selenizone which bears closely spaced concave thread-like ridges; above this they seem to be approximately transverse but slightly curved with a very shallow sinus below suture and bent backward adjacent to selenizone; nearly straight on lower whorl surface. Suture located below selenizone by half its width. Aperture and depth of slit poorly known.

Comparisons.—This species differs from *Platyzona trilineata* (Hall, 1857), a Middle Mississippian (Spergen Hill) species from Indiana, in having more sharply rounded whorls and less prominent growth lines. It also differs from *P. broadheadi* (White, 1880), a Pennsylvanian form from Missouri in having a broader selenizone and narrower revolving lirae.

Measurements.—Measurements are given in Table 39.

TABLE 39. Measurements (in mm.) of *Platyzona americana* n. sp.

Specimen FMNH UC	H	W	Hs	Hf	Pa	Nw	H/W	H/Hf
56354	17.2	11.9	...	11.4	45°	6+	....	....
56355-B	14.2	9.3	4.9	9.3	57°	7	1.53	1.53
56355-E	10.3+	7.1	...	7.1	57°	6+	....	....
56355	10.9+	6.9	...	7.0	50°	6+	....	....
56355-A	12.0+	8.6	...	8.0	56°	6+	....	....
56355-D	7.8	5.6	2.4	5.2	68°	6	1.39	1.50
30488	8.4	6.0	2.1	6.3	63°	7	1.40	1.33

Material, stratigraphic position, and locality.—Twenty-two specimens from a single locality. Holotype FMNH UC 56354, five specimens FMNH UC 56355, 16 specimens FMNH UC 30488, Golconda Limestone, Locality 9.

Platyzona sp. indet. 1. Figure 75.

Description.—This species resembles the last species except that it is twice as large, the selenizone is located slightly above mid-height of the whorl and is bounded by grooves. It seems to have a wider umbilicus, and the growth lines are relatively more prominent.

Measurements. (in mm.).—Width—16.4; pleural angle—62 degrees.

Material, stratigraphic position, and locality.—One incomplete, partly exfoliated specimen FMNH UC 25994, Lower Okaw Limestone, Locality 23.

Platyzona sp. indet. 2. Figure 76.

Description.—This species resembles *Platyzona* sp. indet. 1 except the lirae on upper whorl surface are fewer and much stronger and

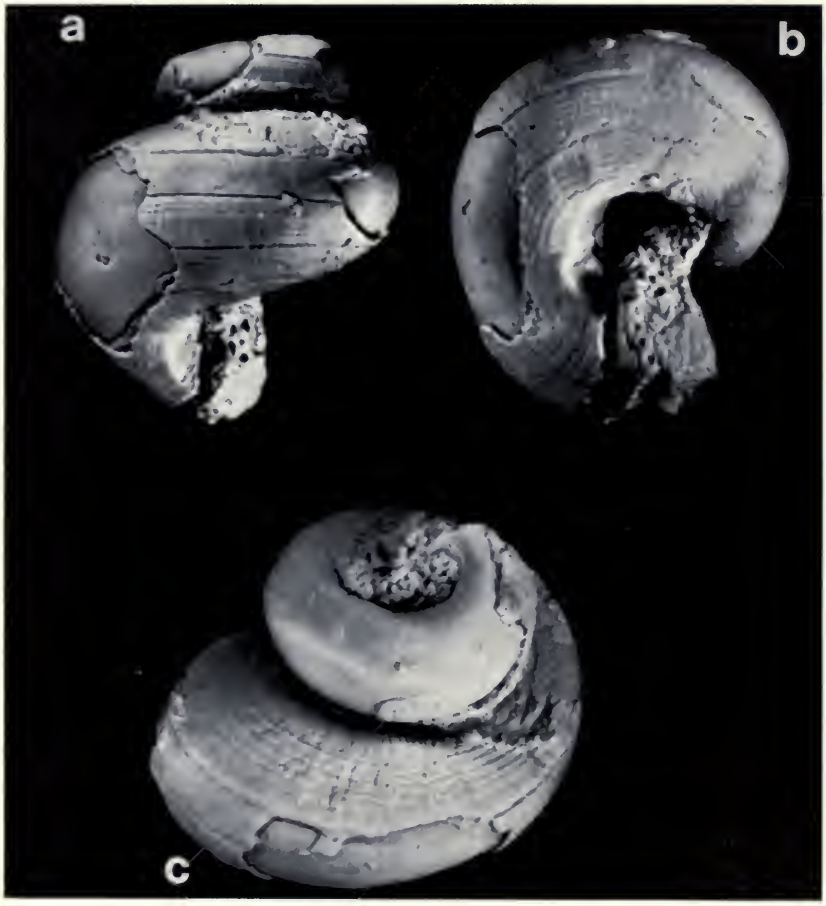


FIG. 75. *Platyzona* sp. indet. 1. **(a)** dorsal view, × 3 (FMNH UC 25994); **(b)** oblique umbilical view, × 3, same specimen; **(c)** oblique apical view, × 3.5, same specimen.

growth lines are extremely faint. Final whorl is quite compressed, with a narrow horizontal band just below the suture.

Comparison.—The rather broad and strong lirae suggest *Platyzona broadheadi* (White, 1880), but the latter species has a much narrower selenizone and less sharply rounded whorls.

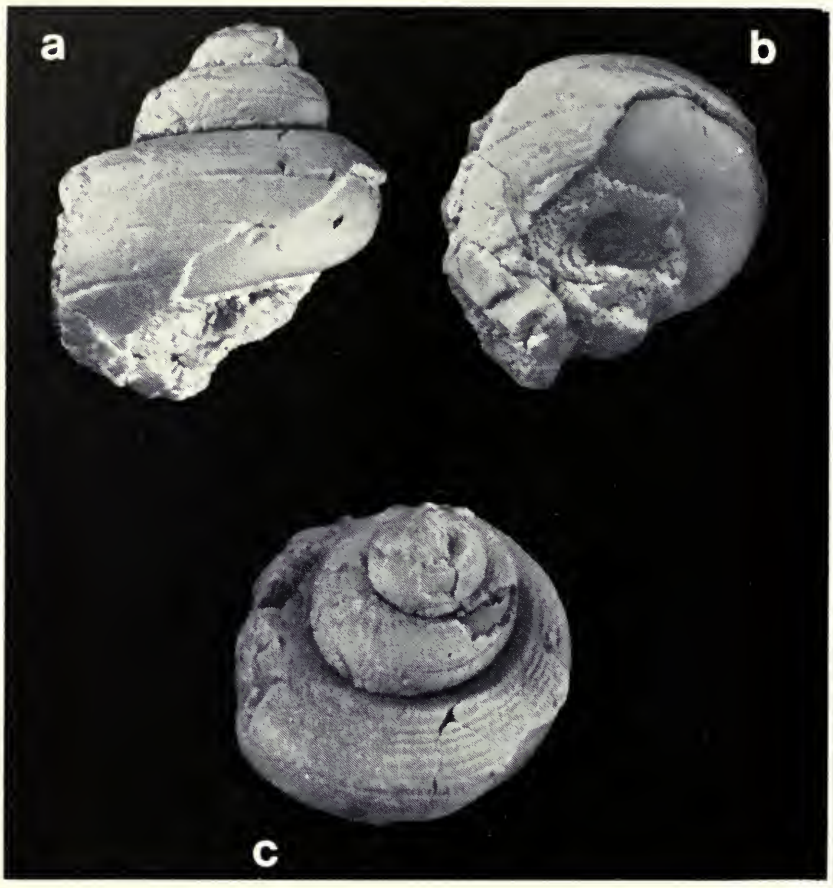
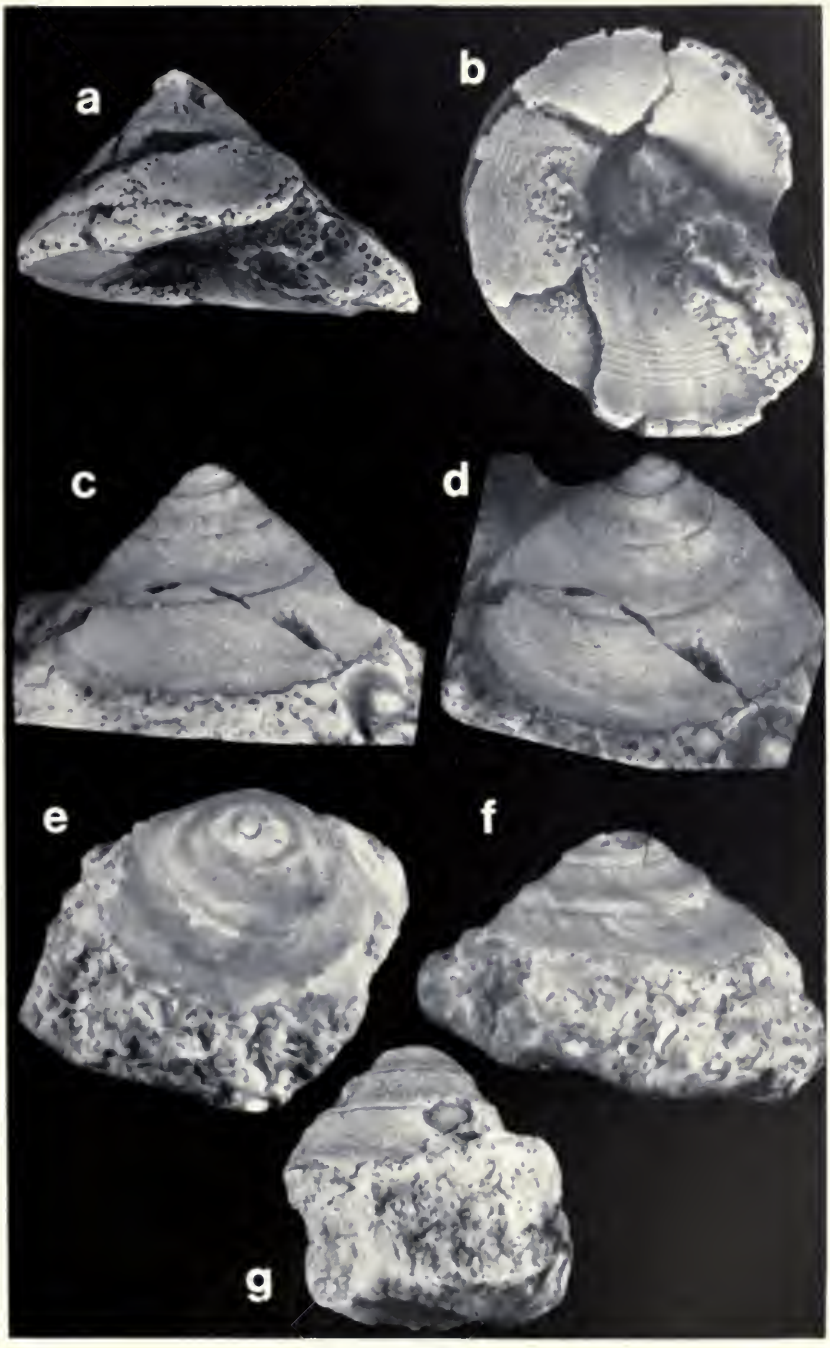


FIG. 76. *Platyzona* sp. indet. 2. **(a)** dorsal view (FMNH UC 30343-A); **(b)** oblique umbilical view, same specimen; **(c)** oblique apical view, same specimen. All × 3.5.

→

FIG. 77. *Eotrochus marigoldensis* n. sp. **(a)** apertural view, × 3.5 (56359); **(b)** umbilical view showing basal ornament and part of marginal frill at lower margin of picture, × 3.5, same specimen; **(c)** spire whorls of holotype, × 5 (56358); **(d)** oblique apical view, × 5, same specimen; **(e)** oblique apical view, × 6 (56360); **(f)** spire whorls, × 6, same specimen; **(g)** spire whorls, × 6 (56361). All FMNH UC.


a
b
c
d
e
f
g

Material, stratigraphic position, and locality.—Two poorly preserved specimens FMNH UC 30343 from a single locality, Glen Dean Limestone, Locality 12.

Suborder Uncertain

Superfamily Pseudophoracea S. A. Miller, 1889

Family Pseudophoridae S. A. Miller, 1889

Genus **Eotrochus** Whitfield, 1882

Type species.—*Pleurotomaria concava* Hall, 1858.

Definition.—With flat base within short frill; narrowly phaneromphalous with lamella spiralling up within umbilicus from base of inner lip; ornament spiral threads on base and growth lines above.

Stratigraphic range.—Middle (Salem Limestone, Redwall Limestone) to Upper Mississippian. (Lower Okaw Limestone).

Discussion.—Only three species of *Eotrochus* have been reported from the Mississippian of North America, *E. concavus* (Hall, 1858) (see Knight, 1941, pp. 113–114, pl. 58, figs. 3a, 3b) from the Salem Limestone of Indiana, an unnamed species by S. Weller (1916, p. 257, pl. 18, figs. 40–41) from the Ste. Genevieve Limestone of Illinois, and *Etrochus*? sp. from the Redwall Limestone of Northern Arizona (Yochelson, 1969a, pl. 60, fig. 6).

Eotrochus marigoldensis new species. Figure 77.

Description.—Shells trochiform with wide, deep umbilicus, and a flat, concave base bordered by a short and even frill. Protoconch consisting of about 2½ smooth and convex whorls, followed by two whorls with generally concave profile but a convex section varying in position from either near the upper or lower sutures. Mature whorl profile nearly flat between sutures, more gently sloping than the previous ones. Final whorl strongly angulated at the periphery with a lamellar extension on the outer shell surface. Sutures shallow, at the edge of the frill of the previous whorl. Base phaneromphalous, nearly flat, but concave near the peripheral frill, and gently sloping into the umbilicus. Parietal lip seemingly with a very thin deposition of inductura. Columella cone-shaped in axial section. Upper whorl surface with numerous thin and rounded revolving lirae, 19 to 25 on the fifth whorl, intersected by sparsely and irregularly spaced growth lines which are common on the mature whorls and are strongly prosocline. Mature whorls of some specimens have low, linear nodes

developed between the growth lines near the upper suture which gradually disappear about half way to the basal suture. The basal whorl surface bears 12 or more rounded revolving lirae, stronger than those of the upper surface and more widely spaced but they are either very faint or absent near the marginal frill. Growth lines extremely faint and slightly prosocline on the lower surface.

Comparisons.—*Eotrochus marigoldensis* n. sp. is similar in many respects to *E. concavus* (Hall, 1858) but differs by having stronger and more distinct revolving lirae, and a relatively wider pleural angle. S. Weller's specimens, which we have examined, are too fragmentary and poorly preserved to make proper comparisons. A fairly well-preserved portion of the basal part of one specimen shows, however, greater convexity of the lower surface and more sinuous growth lines.

Measurements.—Measurements are given in Table 40.

TABLE 40.—Measurements (in mm.) of *Eotrochus marigoldensis* n. sp.

Specimen FMNH UC	H	W	Pa
25052	3.8	6.4	85°
25325	5.6	8.9	80°
56359	8.9	15.4	87°
25106	5.8	8.7	92°

Material, stratigraphic positions, and localities.—Fifteen specimens from four localities. Holotype FMNH UC 56358, one specimen FMNH UC 56359 and five specimens FMNH UC 25325, Lower Okaw Limestone, Locality 2; one specimen FMNH UC 56360, and three specimens FMNH UC 25114, Lower Okaw (Evansville Oolite), Locality 3; one specimen FMNH UC 56361 and two specimens FMNH UC 25106, Lower Okaw Limestone, Locality 11; and one specimen FMNH UC 25052, Lower Okaw (Marigold Oolite), Locality 14.

Order Caenogastropoda Cox, 1959

Superfamily Loxonematacea Koken, 1889

Discussion.—Four families, viz., Loxonematidae Koken, 1889, Palaeozygopleuridae Horný, 1955, Pseudozygopleuridae Knight, 1930, and Zygopleuridae Wenz, 1938, are currently recognized (Knight et al., 1960). The first three families are Paleozoic forms, but the last is restricted to Mesozoic.

Features distinguishing the families are the nature of the labrum and the presence or absence of a median sinus, type of nucleus, and pattern of ornamentation. The Loxonematidae are easily recognized by the presence of a median sinus in addition to the smooth whorls of the nucleus and generally fine collabral ornament. The other families are similar in having a shallow sinus or none at all, and they are only differentiated by the early ontogenetic pattern of development. This knowledge of the protoconch is essential for separating these families, especially the Palaeozygopleuridae and Pseudozygopleuridae of the Paleozoic.

The family Palaeozygopleuridae is distinguished by having a protoconch composed of one or more smooth whorls. In contrast, the Pseudozygopleuridae is characterized by a protoconch having 1 to 1½ smooth whorls followed by whorls ornamented with strong sigmoidal collabral costae up to the fourth volution. The curvature of these early costae is distinctively stronger than that of the adult whorls. The Paleozygopleuridae ranges from Devonian to Upper Mississippian, and the Pseudozygopleuridae from Mississippian to Middle Permian.

The prontoconch of the Zygopleuridae cannot be distinguished from that of Palaeozygopleuridae. It is smooth, and consists of up to three regularly increasing volutions. The shell is typically slender and ornamented by narrow collabral riblets curving parasigmoidally in most genera, although subordinate spiral elements may be present in some. The geologic range is from Triassic to Upper Jurassic.

Longstaff (1933), in describing the British Carboniferous species of Loxonematacea, did not recognize the pseudozygopleurid type of protoconch. She noticed only the zygopleurid type on all her species, and consequently all were referred to the Zygopleuridae. Similarly, all of the Upper Mississippian species in our collection have a protoconch of about two to three smooth and unornamented whorls, followed by whorls having a uniform type of ornamentation throughout. We are reluctant to assign these species in the Mesozoic Zygopleuridae. It seems more appropriate to refer them and Longstaff's species to the Paleozoic Palaeozygopleuridae.

The Loxonemataceae seems to have been closely related to the Murchisoniacea and probably were derived from them. It is also probable that *Loxonema* Phillips, 1841 was ancestral to palaeozygopleurid gastropods, and the latter, in turn, gave rise to Pseudo-

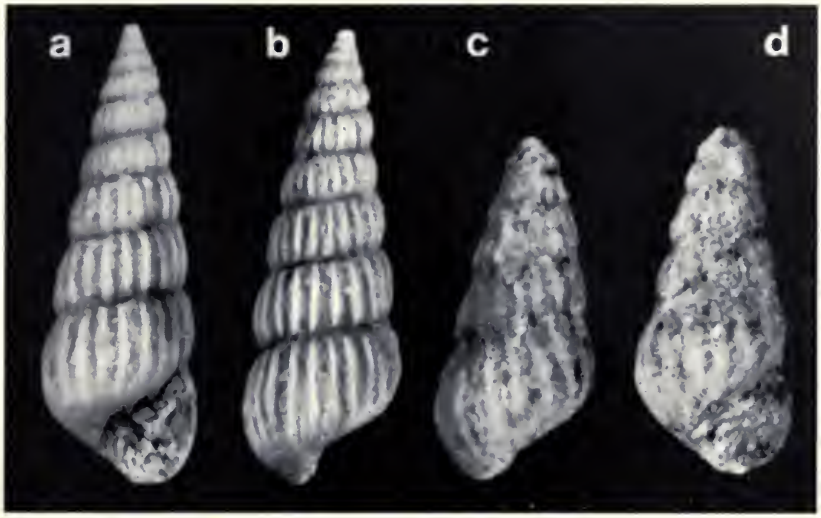


FIG. 78. *Palaeozygopleura venusta* n. sp. **(a)** apertural view of holotype, × 10 (56362); **(b)** dorsal view, × 10, same specimen; **(c)** dorsal view of an immature specimen, × 12 (56363); **(d)** apertural view, × 12, same specimen. All FMNH UC.

zygopleuridae which flourished during the Pennsylvanian and Permian.

Family Palaeozygopleuridae Horný, 1955

Genus **Palaeozygopleura** Horný, 1955

Type species.—*Zygopleura alinae* Perner, 1907.

Definition.—Small, high-spired with shallow labral sinus; whorls evenly convex with shallow to deep sutures; columellar lip thin, slightly reflected; anterior part of outer lip channeled, posterior, rounded or with suggestion of a channel.

Stratigraphic range.—Devonian to Upper Mississippian.

American Mississippian species.—The protoconch of most reported Mississippian species is unknown and thus assignment to the proper genus is impossible. Nevertheless, *Loxonema wortheni* S. Weller, 1916 (p. 261, pl. 18, figs. 18–20), from the Ste. Genevieve Limestone of Illinois, *Loxonema yandellana* Hall, 1857 (p. 28; Hall, 1883, p. 365, pl. 31, figs. 35, 36), from the Salem Limestone of Indiana, *Zygopleura* sp. A Elias, 1958 (pp. 15–16, pl. 2, fig. 3), and *Loxonema* sp. ? Keyes, 1894 (pl. 55, fig. 2), from Burlington Limestone of Missouri, may be referred provisionally to this genus.

Palaeozygopleura venusta new species. Figure 78.

Description.—Shells slender, elongated, turriculated, very small, and composed of as many as ten gradually increasing volutions. Protoconch composed of three smooth convex whorls. Next three whorls decorated with collabral ornaments which are rather sharply convex. Succeeding whorls at maturity are less convex and relatively wider. Sutures deep and well impressed. Base somewhat flattened. Collabral costae rather strong, very slightly curved forward, and somewhat widely spaced between sutures, about 25 on tenth whorl. Fine prosocline collabral threads continue the costae on the base.

Comparisons.—This species resembles *Palaeozygopleura robroystonensis* var. *tenuiscostata* (Longstaff, 1933, p. 102, pl. 8, fig. 3; pl. 12, figs. 8, 9), a British Carboniferous form, in shape of shell and form of whorls, but has stronger ornamentation. It differs from *Pseudozygopleura kellettae* Knight, 1930 (pp. 49–50, pl. 2, figs. 15a, b), a Pennsylvanian species, by having a less extended base and more convex whorls.

Measurements.—Measurements are given in Table 41.

TABLE 41.—Measurements (in mm.) of *Palaeozygopleura venusta* n. sp.

Specimen FMNH UC	H	W	Hs	Hf	Pa	Nw	Pw	H/W	Hs/Hf
56362	5.9	2.1	3.4	2.6	17°	10	3	2.81	1.31
56363	3.1+	2.0	...	...	23°	4+	..	....	....
25032-3	2.6+	1.6	...	...	25°	4+	..	....	....
25032-4	2.4	1.1	...	...	20°	6	3	2.36	....

Material, stratigraphic position, and locality.—Six specimens from a single locality. Two are juveniles but the others are adults. One adult and one juvenile are almost perfectly preserved. Holotype FMNH UC 56362, one specimen FMNH UC 56363 and four specimens FMNH UC 25032, Lower Okaw (Marigold Oolite), Locality 14.

Palaeozygopleura welleri new species. Figure 79.

Description.—Shell with about ten volutions, is more slender than *P. venusta* n. sp. Protoconch consists of 2.5 smooth whorls which are almost as equally convex as those of *P. venusta* n. sp. Collabral ornaments are much weaker, slightly more curved and numerous, about 48 on the tenth whorl. Base also is more elongated, covered with very fine collabral threads. Aperture suborbicular, columellar

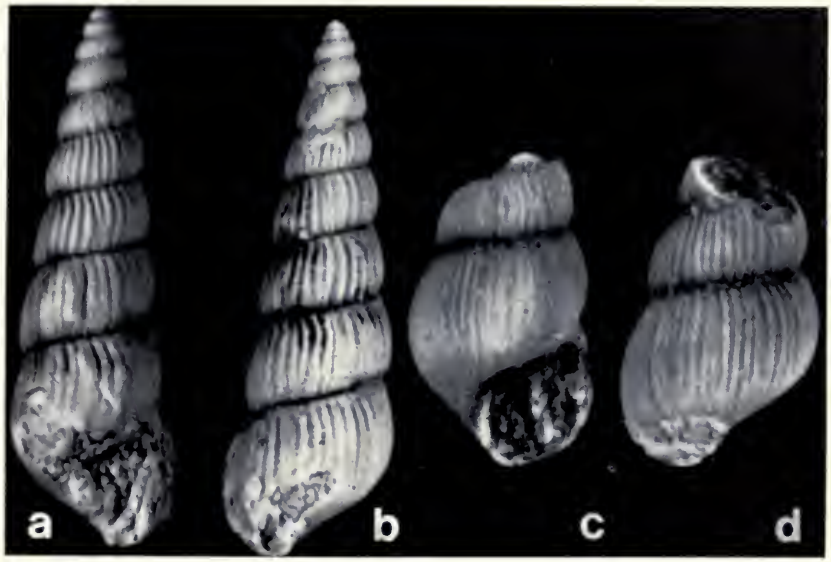


FIG. 79. *Palaeozygopleura welleri* n. sp. **(a)** apertural view of holotype (56364); **(b)** dorsal view, same specimen; **(c)** apertural view (56365); **(d)** dorsal view, same specimen. All FMNH UC. All × 10.

lip straight and slightly reflected. Anterior channel pronounced, and posterior suggested.

Comparisons.—This species resembles *Palaeozygopleura robroystonensis* (Longstaff, 1933, pp. 100–101, pl. 8, figs. 1, 2, 5), in its type of collabral ornament, but is much more slender and the protoconch is more swollen. It differs from *P. scalaroidea* (Phillips, 1863) (see Longstaff, 1933, pp. 97–98, pl. 9, figs. 11–13; Batten, 1966, p. 84, pl. 9, figs. 2, 3) by having stronger ornamentation. The ornamentation suggests *Pseudozygopleura pulchra* Knight, 1930 (pp. 42–43, pl. 2, fig. 4), a Pennsylvanian species, but the form of whorls is different, the basal one being more elongated. It is distinguished from *P. yandellana* (Hall, 1857) by its shorter whorls.

Measurements.—Measurements are given in Table 42.

TABLE 42.—Measurements (in mm.) of *Palaeozygopleura welleri* n. sp.

Specimen FMNH UC	H	W	Hs	Hf	Pa	Nw	Pw	H/W	Hs/Hf
56364	7.1	2.3	4.2	2.9	10°	10	2.5	3.09	1.45
25125-2	3.9+	1.6	...	...	15°	7	2.5	....	....
25025-1	6.4+	2.2	...	...	14°	7+	...	....	....
25025-2	5.0	1.9	2.9	2.1	14°	8.5	3.0	2.63	1.38
25025-3	3.4+	1.4	...	...	16°	6+	...	....	....

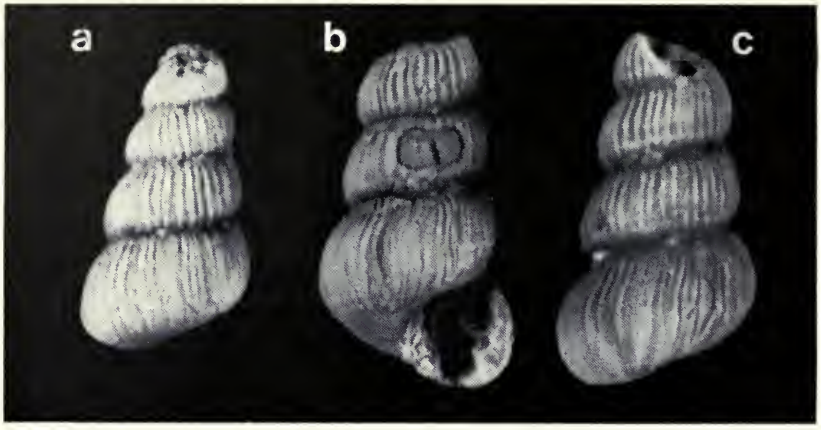


FIG. 80. *Palaeozygopleura* cf. *P. yandellana* (Hall, 1857). **(a)** dorsal view (56366); **(b)** apertural view, same specimen; **(c)** dorsal view (25035). All FMNH UC. All × 10.

Material, stratigraphic positions, and localities.—Twelve specimens from three localities: Holotype FMNH UC 56364 and three specimens FMNH UC 25125, Lower Okaw (Evansville Oolite), Locality 3; one specimen FMNH UC 56365 and two specimens FMNH UC 25031, Lower Okaw (Marigold Oolite), Locality 14; and five specimens FMNH UC 25025; Lower Okaw Limestone, Locality 49.

Palaeozygopleura cf. **P. yandellana** (Hall, 1857). Figure 80.

Description.—This species resembles *P. welleri* n. sp. in most respects, but differs from it as follows: whorls between sutures are more convex and sutures more impressed. Final whorl is more sharply rounded. Collabral ornaments are much thinner and more numerous, about 60 on the final whorl. They curve forward immediately below the upper suture, and then curve backward on most of the lateral face and continue as fine growth lirae on base. Outline of aperture subcircular, columellar lip thin and slightly curved. Protoconch unknown.

Comparisons.—This species greatly resembles *P. yandellana* (Hall, 1857), but the whorls are shorter and base is less extended.

Material, stratigraphic position, and locality.—Two incomplete specimens from a single locality. FMNH UC 56366 and FMNH UC 25035, Lower Okaw (Marigold Oolite), Locality 14.

FIG. 81. *Palaeozygopleura wortheni* (S. Weller, 1916). **(a)** apertural view (25033-A); **(b)** dorsal view, same specimen; **(c)** apertural view (25033-B); **(d)** dorsal view of S. Weller's holotype from the Ste. Genevieve Limestone (56394); **(e)** apertural view, same specimen. All FMNH UC. All × 10.

Palaeozygopleura wortheni (S. Weller, 1916). Figure 81.

Loxonema wortheni. S. Weller, 1916, Contr. Walker Mus., **1**, no. 10, p. 261, pl. 18, figs. 18–20.

Pseudozygopleura wortheni. Knight et al., 1944, Index fossils North Amer., p. 461, pl. 187, figs. 3–5.

Description.—Shell slightly shorter and more robust than in most species. Protoconch poorly known; at least one smooth rounded whorl present. More than seven volutions. Collabral costae slightly curved forward immediately below upper suture, then curved backward on most of the lateral surface, and continued as fine growth lirae on base. The costae are weak, spaced closely and about 30 on final whorl. Base slightly rounded.

Comparisons.—These shells are almost identical with Weller's "cotypes" specimens which are refigured in this paper (fig. 81d, e) in size, form, and type of ornament, except that collabral costae are relatively stronger. The Chester specimens resemble *Palaeozygopleura yandellana* (Hall, 1857), but the whorls are less convex and sutures less impressed.

Measurements (in mm.).—Measurements on the better preserved specimen are: height—5.2+; width—2.6; pleural angle—26 degrees.

Material, stratigraphic position, and localities.—Five specimens from two localities. Holotype: FMNH UC 56394 and two "types" of S. Weller of *Loxonema wortheni* S. Weller, 1916, FMNH UC 14869, and FMNH UC 56395, Locality 48; two specimens FMNH UC 25033, Lower Okaw (Marigold Oolite), Locality 14.

Family Pseudozygopleuridae Knight, 1930

Genus **Palaeostylus** Mansuy, 1914

Type species.—*Palaeostylus pupoides* Mansuy, 1914, subsequently designated by Cossmann, 1918, p. 323.

Definition.—Shell turriculated, with or without collabral ornament.

Stratigraphic range.—Mississippian to Middle Permian.

Subgenus **Stephanozyga** Knight, 1930

Type species.—*Zygopleura nodosa* Girty, 1915.

Definition.—Shell relatively large; collabral ornament weak or missing on upper part of whorls but strong and nodelike below; labral sinus rather deep; protoconch unknown.

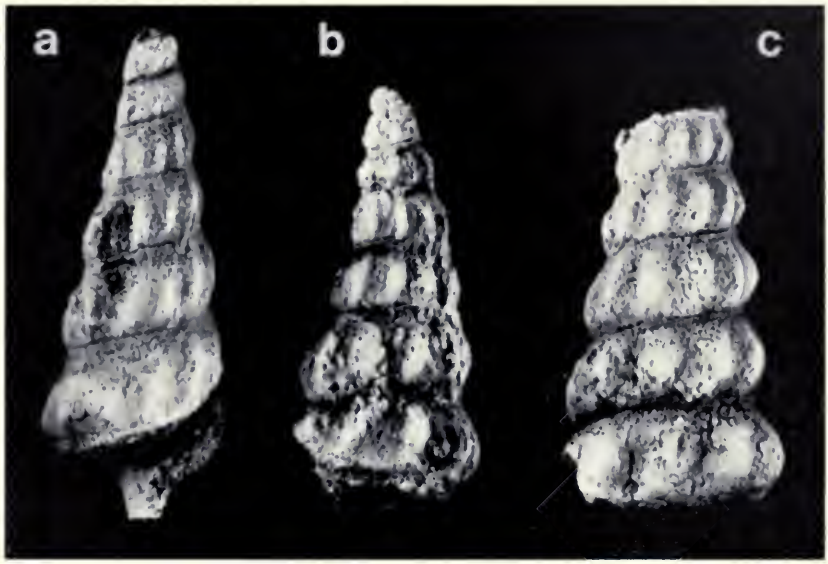


FIG. 82. *Palaeostylus* (*Stephanozyga*) sp. indet. 1. (a) apertural view (30480-1); (b) dorsal view (30480-2); (c) dorsal view (30480-3). All FMNH UC. All × 3.

Stratigraphic range.—Mississippian to Middle Permian.

Palaeostylus (Stephanozyga) sp. indet. 1. Figure 82.

Description.—Whorls relatively short between sutures, final whorl sharply rounded with flattened base. Ornamented only with transverse nodelike costae which are slightly curved, swinging forward a little, weakest on upper part of whorl and strongest at the periphery.

Comparison.—This species resembles *P.* (*S.*) *subnodosa* Knight, 1930 (p. 62, pl. 4, fig. 1), a Pennsylvanian species, but has lower whorls between sutures, and transverse costae that swing forward more conspicuously.

Measurements.—Largest specimen about 20 mm. high, 7.5 mm. wide, and pleural angle of 20 degrees.

Material, stratigraphic position, and locality.—Five poorly preserved steinkerns FMNH UC 30480, Golconda Limestone, Locality 9.

Palaeostylus (Stephanozyga) sp. indet. 2. Figure 83.

Comparisons.—This species differs from the *Palaeostylus* (*Stephanozyga*) sp. indet. 1 by being weakly ornamented.

FIG. 83. *Palaeostylus (Stephanozyga)* sp. indet. 2. **(a)** apertural view (FMNH UC 25599); **(b)** dorsal view, same specimen. All × 5.

Material, stratigraphic position, and locality.—A single specimen FMNH UC 25599 with only last three whorls preserved, Golconda Limestone, Locality 9.

Superfamily Subulitacea Lindström, 1884

Discussion.—As the superfamily is extinct, anatomical features can be inferred only from characters of the shell. The anterior notch and columellar fold probably were associated with an inhalant siphon and the pallial currents presumably made their exit at the angle where the outer lip joins the preceding whorl. Lack of a sinus or slit in the outer lip suggests advanced anatomical asymmetry. Although derivation of the group is uncertain, it is thought that the Loxonematacea probably was closely related to this superfamily.

Family Subulitidae Lindström, 1884

Subfamily Subulitinae Lindström, 1884

Genus **Bulimorpha** Whitfield, 1882

Type species.—*Bulimella bulimiformis* Hall, 1857.

Definition.—Slender, fusiform with gently arched whorls, final whorl more than half of total height; well-developed siphonal fold can be seen in broken specimens.

Stratigraphic range.—Mississippian.

FIG. 84. *Bulimorpha minor* n. sp. **(a)** apertural view of holotype, × 10 (56367); **(b)** dorsal view, × 10, same specimen; **(c)** dorsal view, × 10 (56368-A); **(d)** apertural view, × 10, same specimen; **(e)** apertural view of rather immature specimen, × 10 (56368-B); **(f)** dorsal view, × 10, same specimen; **(g)** section, × 12 (25039-A). All FMNH UC.

American Mississippian species.—The following species which have been described and figured from Mississippian formations of the United States are referred to this genus:

Bulimella bulimiformis Hall, 1857 (see Whitfield, 1882, p. 74, pl. 8, figs. 37–39), Salem Limestone, Indiana.

Bulimorpha elegans Girty, 1927 (p. 432, pl. 25, figs. 31, 32), Brazer Limestone, Southeastern Idaho.

Bulimella elongata Hall, 1857 (see Whitfield, 1882, p. 75, pl. 8, fig. 40), Salem Limestone, Indiana.

Bulimorpha whitfieldi S. Weller, 1916 (pp. 260–261, pl. 18, figs. 15–17), Ste. Genevieve Limestone, Illinois.

Bulimorpha minor new species. Figures 7, 84.

Description.—Shell moderately high-spired with about 7½ volutions, anomphalous, with a small siphonal canal. Final whorl more than half of the total height. Whorl profile between sutures gently arched; suture shallow. Protoconch simple, dextral, consisting of about 2½ convex whorls, but not sharply differentiated. Base slender, extended, anomphalous. Aperture suboval, pointed posteriorly, rounded anteriorly. Columellar lip arcuate with a small siphonal notch; outer lip rather convex above and rounded below. Ornament absent. Shell apparently thin.

TABLE 43.—Measurements (in mm.) of *Bulimorpha minor* n. sp.

Specimen FMNH UC	H	W	Hs	Hf	Ha	Wa	Pa	Nw	Pw
56367	5.3	2.3	2.2	3.1	2.3	1.0	25°	7.5	2.5
25039-2	5.0	2.4	2.0	3.0	1.6	...	29°	6.5	2.5
56368-A	4.1+	2.1	...	...	1.8	1.1	28°	4.0+	...
56368-B	3.9	2.0	1.4	2.5	1.6	1.1	..	5.0	2.0

Remarks.—The ontogenetic growth curve (fig. 7) of this species indicates that some of the specimens are in the mature stage of development. Therefore, the minuteness of the species seems to reflect genetic factors.

TABLE 44.—Ratios of *Bulimorpha minor* n. sp.

Specimen FMNH UC	H/W	Hf/Hs	Ha/Wa
56367	2.30	1.35	2.30
25039-2	2.01	1.88	....
56368-A	....	....	1.64
56368-B	1.95	1.78	1.45

Comparisons.—*Bulimorpha minor* resembles *B. whitfieldi* S. Weller, 1916, a Ste. Genevieve species, in its small size, but it is distinctively more slender. It also resembles *B. elongans* Girty, 1927, a Brazer Limestone species from southeastern Idaho, in form, but the latter seems to be more slender.

Measurements.—Measurements and ratios of measurements are given in Tables 43–45.

TABLE 45.—Measurements (in mm.) of each whorl of *Bulimorpha minor* n. sp.

Specimen FMNH UC		Whorl No.				
		−2	−1	0	+1	+2
56367	H	0.20	0.30	0.50	0.90	1.20
	W	0.50	0.70	1.00	1.50	2.00
	H/W	0.40	0.43	0.50	0.60	0.60
25039-2	H	....	0.30	0.50	0.90	1.40
	W	....	0.70	1.00	1.50	2.10
	H/W	....	0.43	0.50	0.60	0.67
56368-A	H	....	0.30	0.50	0.85	....
	W	....	0.70	1.00	1.60	....
	H/W	....	0.43	0.50	0.53	....
56368-C	H	....	0.30	0.50	0.90	....
	W	....	0.70	1.00	1.40	....
	H/W	....	0.43	0.50	0.64	....
N	H/W	1	4	4	4	2
Total	H/W	0.40	1.72	2.00	2.37	1.27
Mean	H/W	0.40	0.43	0.50	0.59	0.64

Material, stratigraphic positions, and localities.—Five specimens from two localities. Holotype: FMNH UC 56367 and two specimens FMNH UC 25039, Lower Okaw Limestone (Marigold Oolite), Locality 14; two specimens FMNH UC 56368, Lower Okaw Limestone, Locality 49.

Genus **Leptoptygma** Knight, 1936

Type species.—*Auriptygma virgatum* Knight, 1931.

Definition.—Fusiform but with rounded base; sutures deep; inductura covering the columella with low fold, but absent in parietal region; siphonal channel very wide and diffuse; ornament absent or with fine collabral threads.

Stratigraphic range.—Mississippian to Pennsylvanian.

American Mississippian species.—*Leptoptygma* sp. Easton, 1942 (pl. 11, figs. 1, 9) from the Pitkin Limestone of Northern Arkansas seems to be the only species figured and reported from the Mississippian formations of the United States.

Leptoptygma golconda new species. Figure 85.

Description.—Shell high, fusiform, anomphalous, with labral inductura having low fold on the columella, but not covering the parietal lip, and with a very wide, diffuse siphonal canal. Volutions about $4\frac{1}{2}$; final whorl more than four times as high as the preceding spire. Whorls somewhat sharply rounded; sutures rather deep. Protoconch smooth, simple, and dextral. Base rounded and some-

FIG. 85. *Leptoptygma golconda* n. sp. **(a)** apertural view of holotype (FMNH UC 31704-1); **(b)** dorsal view, same specimen; **(c)** anterior dorsal view showing trend of growth lines, same specimen. All × 3.

what extended, anomphalous. Columellar lip slightly arcuate, parietal lip seemingly with a thin inductura, outer lip convex. Ornament consisting of fine irregularly spaced collabral threads slightly prosocline for a short distance near the upper suture, arch forward across most of the area, but change to very slight forward swing on the base. Shell moderately thick.

Comparisons.—This species differs from *Leptoptygma* sp. Easton (1942, pl. 11, fig. 9), from the Pitkin Limestone of northern Arkansas by having more rounded whorls. The ornament of this species resembles that of *L. subtilistriatum* (Knight, 1931a, p. 225, pl. 25, figs. 1a–b) but is much weaker and the final whorl is more rounded.

Measurements.—Measurements are given in Table 46.

TABLE 46.—Measurements (in mm.) of *Leptoptygma golconda* n. sp.

Specimen FMNH UC	H	W	Hs	Hf	Ha	Wa	Pa	Nw	H/W	Hf/Hs
31704-1	15.9+	11.9	...	12.6	2.8	6.5	60°	4.0+	....	...
31704-2	5.5	3.8	1.0	4.5	2.9	2.1	63°	4.5	1.45	4.5

Material, stratigraphic position, and locality.—Two specimens from a single locality. Holotype: FMNH UC 31704-1 and one specimen FMNH UC 31704-2, Lower Golconda Limestone, Locality 13.

Genus **Globozyga** new genus

Type species.—*Globozyga tenuistriata* n. sp.

Definition.—Widely fusiform with about 2½ smooth whorls on protoconch; ornamented with collabral lirae having a very shallow sinus near upper suture and swinging backward below to base; sutures shallow; columellar lip slightly curved, upper part covered with thin inductura; juncture of upper lip and penultimate whorl angular, collumellar lip rounded.

Stratigraphic range.—Upper Mississippian.

Comparisons.—*Globozyga* n. g. resembles *Hemizyga* Girty, 1915 *sensu stricto*, in general form, but is without spiral ornamentation on the body whorl, the whorls are less rounded, and the sutures less impressed. It is like *Eoptychia* Longstaff, 1933, but is less elongated, has a more inflated whorl profile and less angular base.

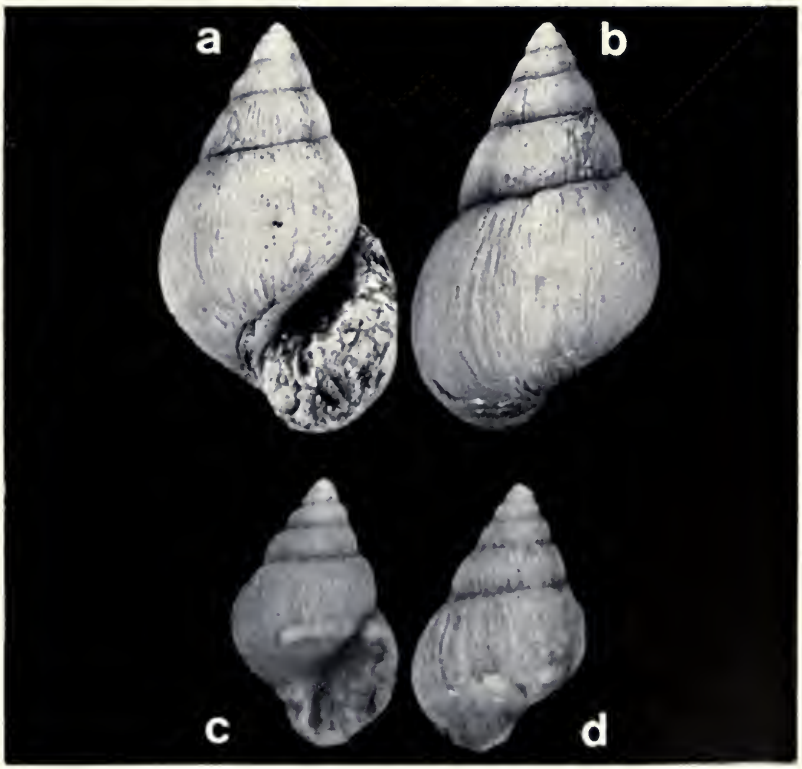


FIG. 86. *Globozyga tenuistriata* n. sp. **(a)** apertural view of holotype, × 5 (25581); **(b)** dorsal view, × 5, same specimen; **(c)** apertural view of younger specimen, × 10 (25176); **(d)** dorsal view, × 10, same specimen. All FMNH UC.

Globozyga tenuistriata new species. Figure 86.

Description.—Shell small, turbiniform, spire moderately high, composed of seven gradually increasing volutions. Protoconch consists of about 2½ smooth, convex, rather rapidly enlarging whorls. Adult whorls slightly convex laterally, wider below. Sutures slightly impressed. Ornament consists only of numerous, fine, rounded collabral lirae, about 88 on seventh whorl, extending from upper suture to columellar lip, with interspaces as wide as the lines. Growth lines concave forward immediately below upper suture, but are convex below on most of the outer whorl surface and base. Base rounded, anomphalous Columellar lip oblique, without fold, slightly reflexed, a little thickened with inductura above. Parietal lip seemingly with thin inductura. Outer lip forms a posterior channel at junction with body whorl, anterior portion rounded. Aperture somewhat orbicular, but distorted by the re-entrance of the body whorl. Shell structure unknown.

Measurements.—Measurements are given in Table 47.

TABLE 47.—Measurements (in mm.) of *Globozyga tenuistriata* n. sp.

Specimen FMNH UC	H	W	Hs	Hf	Ha	Wa	Pa	Nw	Pw	H/W	Hs/Hf
25581	10.8	6.9	3.8	7.0	5.8	4.0	46°	7	2.5	1.56	0.54
25176	3.6	2.1	1.1	2.5	1.7	1.3	50°	6	2.5	1.72	0.44

Material, stratigraphic positions, and localities.—Two specimens from two localities, one juvenile, the other adult, both well preserved. Holotype FMNH UC 25581, Golconda Limestone, Locality 51; one specimen FMNH UC 25176, Lower Okaw (Marigold Oolite), Locality 14.

Subfamily Soleniscinae Wenz, 1938

Genus **Ianthinopsis** Meek and Worthen, 1866

Type species.—*Platyostoma ? tumida* Meek and Worthen, 1861.

Definition.—Form variable from globular with pointed apex to high-spired fusiform; ornament usually absent, but sometimes faint spiral ridges may be present; strong columellar siphonal fold present, generally seen only when aperture is broken, fold usually resorbed in all but last one or two whorls; an obscure parietal fold may appear as a broadly arched thickening of the parietal inductura.

Stratigraphic range.—Middle Devonian to Middle Permian.

American Mississippian species.—The following species reported and figured from Mississippian formations of the United States are referred to this genus:

Macrochilina keyesi Rowley, 1900 (p. 268, pl. 5, figs. 65–66), Lower Burlington Formation, Missouri.

Natica littonana Hall, 1857 (see Whitfield, 1882, p. 72, pl. 8, fig. 28), Salem Limestone, Indiana.

Polyphemopsis melanoides Whitfield, 1882 (see Whitfield, 1891, p. 592, pl. 14, fig. 13), Maxville Limestone, Ohio.

Macrocheilus pinguis Winchell, 1863 (see S. Weller, 1900, *Sphaerodoma pinguis*, p. 108, pl. 6, figs. 1–2), Chonopectus Sandstone, Iowa.

Strobeus reticulatus Hyde, 1953 (p. 335, pl. 48, figs. 7–11), Logan Formation, Ohio.

Machrocheilus stinesvillensis Cumings, 1906, (p. 1341, pl. 24, figs. 10, 10a), Salem Limestone, Indiana.

Machrocheilus subcorpulentus Whitfield, 1882 (see Whitfield, 1895, p. 478, pl. 10, fig. 14), Maxville Limestone, Ohio.

Machrochilina tantilla Rowley 1900 (p. 268, pl. 5, figs. 57–58), Lower Burlington Formation, Missouri.

Ianthinopsis littonana (Hall, 1857). Figure 87.

Natica littonana. Hall, 1857, Adv. Trans. Albany Inst., **4**, pp. 30–31; Hall, 1864, Trans. Albany Inst., **4**, pp. 30–31.

Machrocheilus littonanum. Whitfield, 1882, Bull. Amer. Mus. Nat. Hist., **1**, p. 72, pl. 8, fig. 28; Hall, 1883, 12th Rept. Geol. Surv. Ind., p. 369, pl. 31, fig. 28; Cumings, 1906, 30th Ann. Rept. Geol. Surv. Ind., p. 1341, pl. 25, fig. 28.

Sphaerodoma littonana. Keyes, 1889, Proc. Acad. Nat. Sci. Phila., p. 305; Girty, 1915b, Bull. U.S. Geol. Surv. no. 544, p. 199.

Strobeus littonanus. Knight *et al.*, 1944, Index fossils, p. 479, pl. 196, fig. 13.

Description.—Shell robust, rather subglobular. Spire very short, about one-sixth of the total height. Final whorl large, sub-globular, more than four times as high as the preceding spire. Whorl profile between sutures convex; suture shallow, but impressed. Protoconch not known. Base rounded, anomphalous. Inductura rather thick. Lower portion of columella unknown. Ornament seemingly lacking. Shell moderately thick.

Comparisons.—This species resembles *Ianthinopsis primogenius* (Conrad, 1835), a common Pennsylvanian species, but it is more

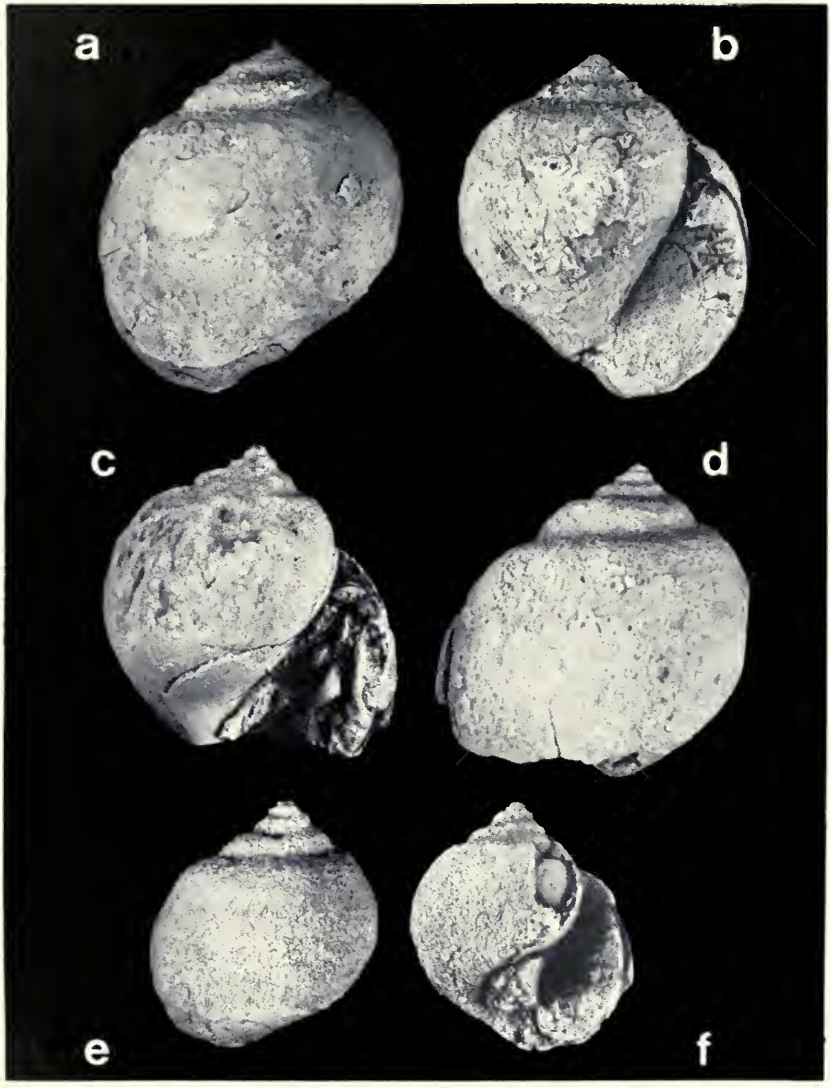


FIG. 87. *Ianthinopsis littonana* (Hall, 1857). **(a)** dorsal view (30482-A); **(b)** apertural view, same specimen; **(c)** apertural view (30482-B); **(d)** dorsal view, same specimen; **(e)** dorsal view (30482-C); **(f)** apertural view, same specimen. All FMNH UC. All × 2.

globular and the spire is lower. It also resembles *I. welleri* (Knight, 1931a, pp. 219–220, pl. 23, figs. 1a–d), another Pennsylvanian species, but the latter is very small and smoothly rounded.

Measurements.—Measurements are given in Table 48.

TABLE 48.—Measurements (in mm.) of *Ianthinopsis littonana* (Hall, 1857)

Specimen FMNH UC	H	W	Hs	Hf	Pa	Nw
30482-A	22.7	18.5	3.4	15.1	110°	6
30482-B	19.5+	20.0	3.4	....	95°	6+
30482-C	15.7+	14.0	3.0+	....	104°	5+
30482-D	10.1+	9.4	1.4	....	105°	5+

Material, stratigraphic position, and locality.—Six rather poorly preserved specimens FMNH UC 30482, Golconda Limestone, Locality 9.

Ianthinopsis cf. **I. paludinaeformis** (Hall, 1858). Figure 88.

Macrocheilus paludinaeformis. Hall, 1858, Rept. Geol. Surv. Iowa, **1**, pt. 2, pp. 719–720, pl. 29, fig. 10.

Macrocheilus ventricosus. Hall, 1858, Rept. Geol. Surv. Iowa, **1**, pt. 2, pp. 718–719, pl. 29, fig. 8.

Soleniscus (*Macrocheilus*) *paludinaeformis.* White, 1884, Proc. U.S. Natl. Mus., **6**, p. 187, pl. 8, fig. 17.

Soleniscus paludinaeformis. Mark, 1912, Bull. Ohio Geol. Surv., 4th ser., no. 17, p. 317, pl. 16, fig. 17.

Soleniscus brevis. Mark, 1912, Bull. Ohio Geol. Surv., 4th ser., no. 17, p. 318, pl. 16, fig. 18.

Sphaerodoma ventricosa. Girty, 1915b, Bull. U.S. Geol. Surv., no. 544, p. 213, pl. 24, figs. 4–4a.

Sphaerodoma brevis var. Girty, 1915b, Bull. U.S. Geol. Surv., no. 544, p. 204, pl. 24, figs. 7–7a.

Sphaerodoma brevis. Morningstar, 1922, Bull. Ohio Geol. Surv., 4th ser., no. 25, p. 261, pl. 15, figs. 22–24; Morgan, 1924, Bull. Okla. Bur. Geol., no. 2, pl. 50, figs. 5–5a.

Sphaerodoma gracilis. Morgan, 1924, Bull. Okla. Bur. Geol., no. 2, pl. 50, fig. 6.

Sphaerodoma intercalcaris. Morgan, 1924, Bull. Okla. Bur. Geol., no. 2, pl. 50, fig. 7.

Soleniscus (*Macrochilina*) *paludinaeformis.* Knight, 1931a, Jour. Paleontol., **5**, pp. 213–215, pl. 23, figs. 2a–m; pl. 27, fig. 6.

Strobeus paludianeformis. Knight *et al.*, 1944, Index fossils North Amer., p. 479, pl. 196, fig. 9.

Ianthinopsis paludianeformis, Hoare, 1961, Univ. Mo. Studies, **36**, pp. 191–192, pl. 23, figs. 14–15.

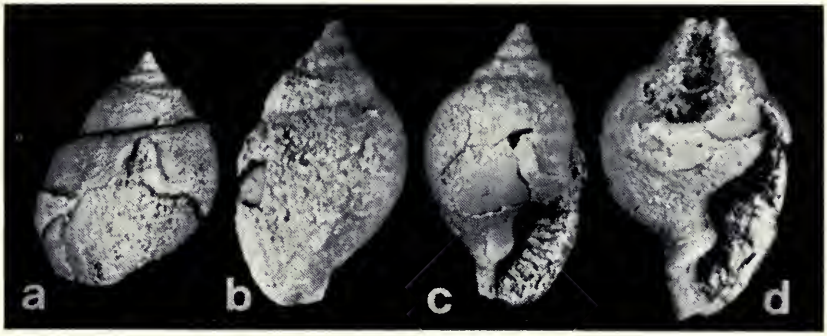


FIG. 88. *Ianthinopsis* cf. *I. paludinaeformis* (Hall, 1858). **(a)** dorsal view, × 2 (30489-A); **(b)** anterior dorsal view, × 2 (30489-B); **(c)** apertural view, × 2, same specimen; **(d)** apertural view, × 3 (30489-C). All FMNH UC.

Description.—Shell small, suboval, with a moderately low spire, strong columellar fold, and siphonal canal. Final whorl large in proportion to height. Profile gently rounded and somewhat extended. Sides of spire slightly concave. Sutures shallow, not impressed. Parietal inductura moderately thickened; siphonal fold strong, with a distinct siphonal sinus. Ornament seemingly absent. Shell moderately thick.

Remarks.—As the specimens are poorly preserved, definite identification is impossible. These specimens, however, closely resemble *Ianthinopsis paludinaeformis*, a common Pennsylvanian species.

Measurements.—Measurements are given in Table 49.

TABLE 49.—Measurements (in mm.) of *Ianthinopsis* cf. *I. paludinaeformis* (Hall, 1858)

Specimen FMNH UC	H	W	Pa
30489-B	17.8	11.3	72°
30489-A	15.2+	12.8	68°
30489-C	14.1+	9.7	..
30489-D	18.0+	10.1+	..

Material, stratigraphic position, and locality.—Four rather poorly preserved specimens FMNH UC 30489, Golconda Limestone, Locality 9.

Genus **Soleniscus** Meek and Worthen, 1861

Type species.—*Soleniscus typicus* Meek and Worthen, 1861.

Definition.—Fusiform, with small siphonal notch visible externally; small siphonal canal present internally with more or less elevated parietal fold somewhat above it; ornament absent.

Stratigraphic range.—Mississippian to Middle Permian.

American Mississippian species.—The following species have been described and figured:

Soleniscus glaber Cumings, 1906 (p. 1,363, pl. 24, figs. 9–9a), Salem Limestone, Indiana.

Soleniscus (*Macrochilina*) *regularis* var. Elias, 1958 (p. 21, pl. 2, figs. 8–10), Late Mississippian, Southern Oklahoma.

Soleniscus sp. Easton, 1962 (p. 101, pl. 13, fig. 19), Heath Formation, Central Montana.

Soleniscus sp. indet. Figure 89.

Description.—Shell fusiform, having about seven volutions, anomphalous, with a siphonal notch visible externally, and a siphonal canal present internally above which is a somewhat elevated parietal fold. Final whorl more than half of total height; whorl profile between sutures gently arched; suture shallow. Protoconch simple, dextral, not sharply differentiated. Base rather evenly rounded, extended, anomphalous. Aperture suboval, pointed posteriorly, rounded anteriorly. Columellar lip arcuate, with a small siphonal notch and a single small fold somewhat above it. Parietal inductura very thin. Outer lip convex above, rounded below. Ornament lacking, except for extremely faint and rather vertical growth lines.

FIG. 89. *Soleniscus* sp. indet. **(a)** apertural view (56369-A); **(b)** dorsal view, same specimen; **(c)** dorsal view (56369-B); **(d)** apertural view, same specimen. All FMNH UC. All × 10.

TABLE 50.—Measurements (in mm.) of *Soleniscus* sp. indet.

Specimen FMNH UC	H	W	Hs	Hf	Ha	Wa	Pa	Nw	Pw
56369-A	5.0	2.5	1.9	3.1	2.0	1.2	29°	7	2
56369-B	4.4	2.5	1.4	3.0	2.0	1.1	36°	6	...

Comparison and remarks.—These shells differ from *Bulimorpha minor* by their robust form. These two specimens are not adequate for the establishment of a new species.

Measurements.—Measurements and ratios of measurements are given in Tables 50 and 51.

TABLE 51.—Ratios of *Soleniscus* sp. indet.

Specimen FMNH UC	H/W	Hf/Hs	Ha/Wa
56369-A	2.00	1.63	1.67
56369-B	1.76	2.14	1.82

Material, stratigraphic position, and locality.—Two specimens FMNH UC 56369, Lower Okaw (Marigold Oolite), Locality 14.

Family Meekospiridae Knight, 1956

Genus **Meekospira** Ulrich in Ulrich and Scofield, 1897

Type species.—*Eulima? peracuta* Meek and Worthen, 1861.

Definition.—Slender, sharply acuminate, eulimiform; columellar lip somewhat arcuate, reflexed; inductura not covering upper part of parietal lip.

Stratigraphic range.—Mississippian to Lower Permian.

American Mississippian species.—Only two species of *Meekospira* have been reported so far from Mississippian formations of the United States, *M. minuta* S. Weller (1916, pp. 261–262, pl. 18, fig. 9) from the Ste. Genevieve Limestone of Illinois, and *M. bella* (Walcott, 1884, pp. 258–259, pl. 24, figs. 1a–b) from the Lower Carboniferous of Nevada. Four additional new species are reported in the present paper.

Meekospira bambooformis new species. Figures 90, 91.

Description.—Shell very small, slender, sharply acuminate, eulimiform, anomphalous, of about 9½ volutions. Height of final whorl less than that of preceding spire. Whorl profile between sutures slightly convex, but flattened along a narrow zone below the suture which is shallow. Protoconch simple, dextral, consists of about

FIG. 90. *Meekospira bambooformis* n. sp. **(a)** apertural view (56371); **(b)** dorsal view, same specimen; **(c)** dorsal view of holotype (56370); **(d)** apertural view, same specimen; **(e)** dorsal view (56372); **(f)** apertural view, same specimen; **(g)** section (25049-A). All FMNH UC. All × 10.

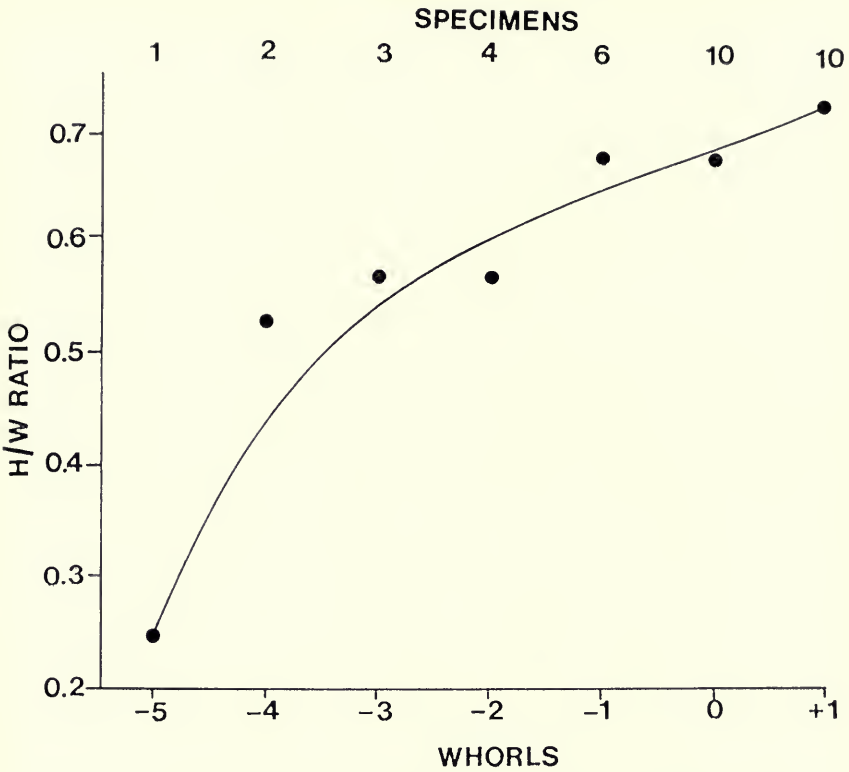


FIG. 91. Curve showing average height to width ratio of ten specimens of *Meekospira bambooformis* n sp..

three rounded whorls. Base generally rounded, anomphalous. Aperture moderate in size, somewhat lens-shaped, higher than wide, pointed posteriorly and rounded anteriorly. Columellar lip slightly arcuate, a little reflexed; parietal lip rather steeply inclined. Parietal inductura very thin, not covering upper part of parietal lip. Outer lip very gently convex, above; sharply convex below. Ornament absent except for extremely faint growth lines which are slightly arched forward. In section the shell seems to be very thin, without two distinct layers.

Comparisons.—*M. bambooformis* n. sp. differs from *M. evansvillensis* n. sp. by its more gently rounded and extended base, and the absence of basal spiral ornament. It differs from *M. peracuta*, the type species, by its more slender shape. It resembles *M. minuta* S. Weller, 1916, a Ste. Genevieve species, but also appears to be more slender than that form.

TABLE 52.—Measurements (in mm.) of *Meekospira bambooformis* n. sp.

Specimen FMNH UC	H	W	Hs	Hf	Ha	Wa	Pa	Nw	Pw
25049-B	7.0	1.9	3.7	3.3	...	...	13°	9.5	3
56371	6.7+	2.1	...	3.9	2.2	1.2	14°	4.0+	.
56370	7.2	2.0	3.8	3.4	2.1	1.0	12°	7.0+	1+
25049-4	5.1+	1.7	...	...	...	...	14°	7.0+	1+
56372	5.7+	1.9	...	3.0	1.8	0.9	...	5.0+	.
25049-6	6.5+	3.1	...	3.5	2.0	0.9	...	...	.
25129-1	6.3+	2.1	...	4.0	2 5	1.3	12°	4.0+	.
25129-2	6.5+	2.1	...	4.0	2.3	1.2	14°	4.0+	.
25129-3	4.9	...	...	...	...	...	17°	3.0+	.
56373-A	5.8+	1.9	...	...	...	...	14°	6.0+	.
56373-B	3.8+	1.8	...	...	...	...	14°	5.0+	.

Measurements.—Measurements and ratios of measurements are given in Tables 52–54.

Ontogeny.—The growth curve (fig. 91) for *Meekospira bambooformis* n. sp. indicates that mature shells are present in the collection.

Material, stratigraphic position, and localities.—Eighteen specimens from three localities. Holotype FMNH UC 56370, one specimen FMNH UC 56371, one specimen FMNH UC 56372 and eight specimens FMNH UC 25049, Lower Okaw (Marigold Oolite), Locality 14; four specimens FMNH UC 25129, Lower Okaw (Evansville Oolite), Locality 3; three specimens FMNH UC 56373, Lower Okaw Limestone, Locality 49.

Meekospira batteni new species. Figures 8, 92–93.

Description.—Shell small, sharply acuminate, eulimiform, anomphalous, with about 9½ volutions in mature individuals. Height of final whorl generally greater than that of the preceding spire. Whorl profile between sutures very slightly convex, nearly flattened along a narrow zone below the suture. Protonconch simple, dextral, consisting of about four convex whorls. Base rather sharply rounded, anomphalous. Aperture moderate in size, somewhat sublenticular. Columellar lip straight, slightly reflexed. Parietal wall gently in-

TABLE 53.—Ratios of *Meekospira bambooformis* n. sp.

Specimen FMNH UC	H/W	Hf/Hs	Ha/Wa
25049-B	3.68	0.89	....
56371	....	....	1.83
56370	3.60	0.89	2.10
56372	....	....	2.00
25049-6	....	....	2.20
25129-1	....	....	1.92
25129-2	....	....	1.92

TABLE 54.—Measurements (in mm.) of each whorl of *Meekospira bambooformis* n. sp.

Specimen FMNH UC		Whorl No.						
		−5	−4	−3	−2	−1	0	+1
	H	0.10	0.23	0.30	0.40	0.70	1.00	1.20
25049-B	W	0.40	0.50	0.70	0.90	1.10	1.45	1.70
	H/W	0.25	0.46	0.43	0.44	0.64	0.69	0.71
	H	....	....	0.40	0.60	0.80	1.00	1.30
56371	W	....	....	0.70	0.90	1.20	1.50	1.70
	H/W	....	....	0.57	0.67	0.67	0.67	0.76
	H	....	....	....	....	....	1.00	1.25
56370	W	....	....	....	....	....	1.50	1.90
	H/W	....	....	....	....	....	0.67	0.66
	H	....	0.30	0.50	0.60	0.80	1.00	1.20
25049-4	W	....	0.50	0.70	0.90	1.10	1.40	1.70
	H/W	....	0.60	0.71	0.67	0.73	0.71	0.71
	H	....	....	....	0.45	0.70	1.00	1.40
56372	W	....	....	....	0.88	1.16	1.40	1.80
	H/W	....	....	....	0.51	0.60	0.71	0.78
	H	....	....	....	....	....	1.00	1.30
25129-1	W	....	....	....	....	....	1.60	1.90
	H/W	....	....	....	....	....	0.63	0.68
	H	....	....	....	....	....	1.00	1.30
25129-2	W	....	....	....	....	....	1.55	1.80
	H/W	....	....	....	....	....	0.65	0.72
	H	....	....	....	....	....	1.00	1.30
25129-3	W	....	....	....	....	....	1.60	1.88
	H/W	....	....	....	....	....	0.63	0.72
	H	....	....	....	....	0.80	1.00	1.40
56373-A	W	....	....	....	....	1.10	1.45	1.80
	H/W	....	....	....	....	0.73	0.69	0.78
	H	....	....	....	....	0.70	1.00	1.15
56373-B	W	....	....	....	....	1.00	1.30	1.52
	H/W	....	....	....	....	0.70	0.77	0.76
N	H/W	1	2	3	4	6	10	10
Total	H/W	0.25	1.06	1.71	2.29	4.07	6.80	7.28
Mean	H/W	0.25	0.53	0.57	0.57	0.68	0.68	0.73

clined at about 45 degrees with the horizontal. Outer lip nearly straight above, but rather strongly convex below. Ornament absent except for extremely faint forwardly swinging growth lines. Shell appears very thin in section, without two distinct layers.

Comparisons.—*Meekospira batteni* n. sp. most closely resembles *M. evansvillensis* n. sp., but is easily distinguished by its more slender form, smaller pleural angle and more extended base, and statistical comparison reveals different growth patterns. This species resembles *M. minuta* S. Weller, 1916, but the latter is more slender and its base is more extended.

Discussion.—As *Meekospira batteni* n. sp. obviously is closely related to *M. evansvillensis* n. sp., a statistical test was employed to

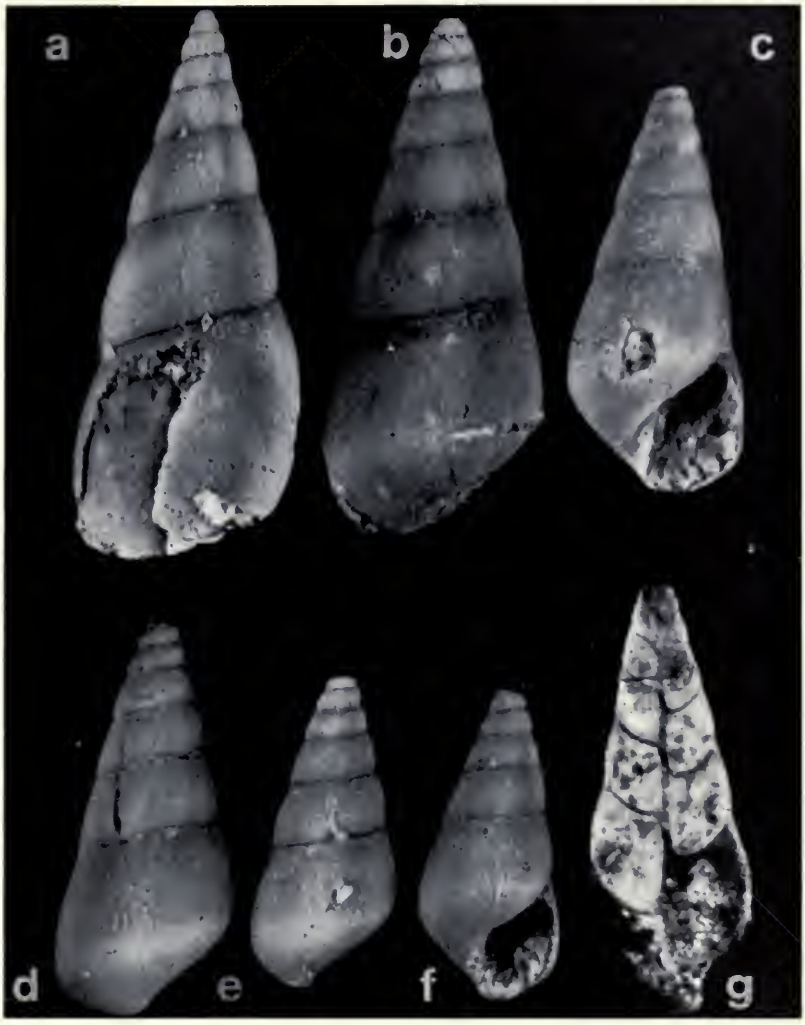


FIG. 92. *Meekospira batteni* n. sp. **(a)** dorsal view, × 8 (56375); **(b)** dorsal view × 10 (56376); **(c)** apertural view of holotype, × 10 (56374); **(d)** dorsal view, × 10, same specimen; **(e)** dorsal view of younger specimen, × 10 (56377); **(f)** apertural view, × 10, same specimen; **(g)** section, × 6 (25048-A). All FMNH UC.

TABLE 55.—Measurements (in mm.) of *Meekospira batteni* n. sp.

Specimen FMNH UC	H	W	Hs	Hf	Ha	Wa	Pa	Nw	Pw
56375	9.0	3.8	4.1	4.9	...	...	21°	8.0	3
25048-2	5.0	2.5	2.1	2.9	1.9	1.0	30°	7.0	3
56376	6.8	3.0	3.3	3.5	...	...	25°	8.0	4
25048-4	6.7	2.8	3.9	...	...	...	20°	8.0	4
56374	5.2	2.4	2.5	2.7	1.9	1.0	24°	7.0	4
25048-6	9.9+	3.9	...	...	...	...	22°	9.5	4
56377	4.0	1.9	1.8	2.2	1.7	1.0	24°	6.5	4
25048-8	3.7	1.9	1.7	2.0	...	...	28°	6.5	4
25048-9	2.6	1.3	1.0	1.3	1.0	0.8	30°	5.0	4
25048-10	2.0	1.2	0.9	1.1	1.0	0.7	30°	5.0	4

supplement the usual qualitative method of species differentiation. The reduced major axis method makes possible the comparison of bivariate growth patterns of these forms. Axes were drawn relating height and width (see Figure 93 and Table 58), and a z test of the slope differences is as follows:

$$z = \frac{a_1 - a_2}{\sqrt{\delta a_1^2 + \delta a_2^2}} = \frac{0.424 - 0.429}{\sqrt{(0.0224)^2 + (0.115)^2}} = 0.427$$

As 0.427 is less than 1.96, a statistical significant difference in slope is not demonstrated at 5 per cent level. Inspection of Figure 93 indicates that the significance of positional difference may be tested at the point $x_0 = \bar{x}_1$ (where $\bar{x}_1$ indicates the mean of height of the sample of *M. evansvillensis* n. sp.). Thus,

$$z = \frac{\bar{x}_1 (a_1 - a_2) + (b_1 - b_2)}{a_2 (\bar{x}_1 - \bar{x}_2)}$$

$$= \frac{4.09 (0.424 - 0.429) + (0.776 - 0.165)}{0.115 (4.09 - 5.0)} = 5.63$$

As z is greater than 2.53, the observed difference in position is taken to be statistically significant at 1 per cent level. Thus, it was concluded that the two forms under consideration should be recognized as two distinct species.

Table 56—Ratios of *Meekospira batteni* n. sp.

Specimen FMNH UC	H/W	Hf/Hs	Ha/Wa
56375	2.37	1.20	....
25048-2	2.00	1.38	1.90
56376	2.27	1.06	....
25048-4	2.39	....	....
56374	2.17	1.08	1.90
25048-6	....	....	....
56377	2.11	1.22	1.70
25048-8	1.95	1.18	....
25048-9	2.00	1.30	1.25
25048-10	1.67	1.22	1.43

TABLE 57.—Measurements (in mm.) of each whorl of *Meekospira batteni* n. sp.

Specimen FMNH UC		Whorl No.								
		−3	−2	−1	0	+1	+2	+3	+4	+5
	H	0.10	0.30	0.40	0.50	0.80	1.30	1.80	....	....
56375	W	0.30	0.50	0.80	1.00	1.50	2.20	3.00	....	....
	H/W	0.33	0.60	0.50	0.50	0.53	0.59	0.60	....	....
	H	....	0.10	0.30	0.50	0.70	0.90	1.30	....	....
25048-2	W	....	0.40	0.70	0.90	1.20	1.70	2.20	....	....
	H/W	....	0.25	0.43	0.56	0.58	0.53	0.59	....	....
	H	....	0.10	0.30	0.50	0.70	1.00	1.30	1.60	....
56376	W	0.40	0.50	0.80	1.00	1.30	1.90	2.40	....	....
	H/W	....	0.20	0.38	0.50	0.54	0.53	0.54	....	....
	H	....	0.20	0.30	0.50	0.60	0.90	1.10	1.40	....
25048-4	W	....	0.60	0.70	1.00	1.30	1.70	2.10	2.80	....
	H/W	....	0.33	0.43	0.50	0.46	0.53	0.52	0.50	....
	H	....	0.20	0.30	0.50	0.60	0.90	....	....	....
56374	W	....	0.60	0.70	1.00	1.30	1.70	....	....	....
	H/W	....	0.33	0.43	0.50	0.46	0.53	....	....	....
	H	....	0.20	0.40	0.50	0.70	1.00	1.20	1.50	1.90
25048-6	W	....	0.70	0.90	1.00	1.50	1.80	2.20	2.70	3.40
	H/W	....	0.29	0.44	0.50	0.50	0.47	0.56	0.55	0.56
	H	....	0.20	0.30	0.50	0.70	....	....	....	....
56377	W	....	0.60	0.75	1.00	1.40	....	....	....	....
	H/W	....	0.33	0.40	0.50	0.50	....	....	....	....
	H	0.10	0.20	0.30	0.50	0.80	....	....	....	....
25048-8	W	0.40	0.60	0.80	1.00	1.50	....	....	....	....
	H/W	0.25	0.33	0.38	0.50	0.53	....	....	....	....
	H	0.10	0.20	0.30	0.50	....	....	....	....	....
25048-9	W	0.30	0.55	0.75	1.00	....	....	....	....	....
	H/W	0.33	0.36	0.40	0.50	....	....	....	....	....
	H	0.10	0.20	0.30	0.50	....	....	....	....	....
25048-10	W	0.30	0.50	0.65	1.00	....	....	....	....	....
	H/W	0.33	0.40	0.46	0.50	....	....	....	....	....
N	H/W	4	10	10	10	8	6	5	2	1
Total	H/W	1.24	3.42	4.24	5.06	4.08	3.26	2.80	1.06	0.60
Mean	H/W	0.31	0.34	0.42	0.51	0.51	0.54	0.56	0.53	0.56

TABLE 58.—Bivariate statistical characterization of *Meekospira evansvillensis* n. sp. and *Meekospira batteni* n. sp.

	M. evansvillensis	*M. batteni*
Total number, N	44	9
Mean of height, $\bar{x}$	4.09	5.0
Mean of width, $\bar{y}$	2.51	2.31
S.D. of x, S_x	1.175	2.097
S.D. of y, S_y	0.498	0.9
Corr. coeff., r	+0.9384	+0.938
Observed range of x, OR_x	1.8–6.7	2.0–9.0
Growth ratio, a	0.424	0.429
Std. error of a, a	0.0024	0.115
Initial growth index, b	0.776	0.165

Ontogeny.—The ontogenic growth curve of this species is shown in Figure 8.

Measurements.—Measurements and ratios of measurements are given in Tables 55–57.

Material, stratigraphic position and locality: Fifteen mature and immature specimens from a single locality. Holotype FMNH UC 56374, one specimen FMNH UC 56375, one specimen FMNH UC 56376, one specimen FMNH UC 56377 and eleven specimens FMNH UC 25048, Lower Okaw (Marigold Oolite), Locality 14.

Meekospira evansvillensis new species. Figures 93–95.

Description.—Shell very small, acuminate, eulimiform, anomphalous with up to 7½ volutions in matured specimens, and with

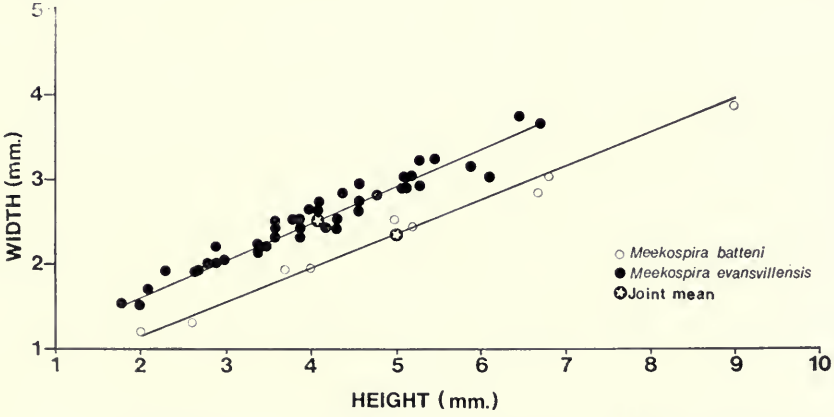


FIG. 93. Growth forms of *Meekospira batteni* n. sp. and *Meekospira evansvillensis* n. sp. characterized by reduced major axes calculated for linear measurements. Reduced major axes were drawn relating height and width of shell. Length of lines corresponds to observed range. Data given in Table 58.

FIG. 94. *Meekospira evansvillensis* n. sp. **(a)** apertural view of holotype (56378) **(b)** umbilical view, same specimen; **(c)** umbilical view (56380); **(d)** dorsal view (56379); **(e)** apertural view, same specimen; **(f)** dorsal view showing growth lines (56382); **(g)** anterior dorsal view showing growth lines (56381).

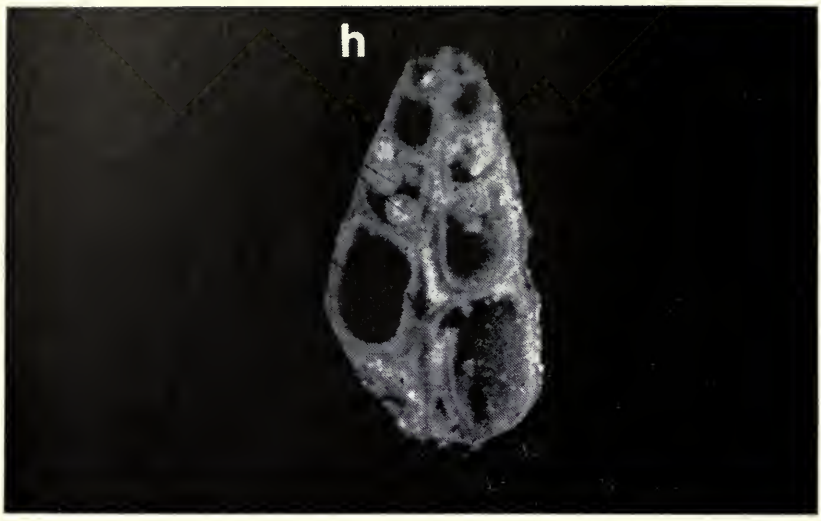


FIG. 94. *Continued.—Meekospira evansvillensis.* n. sp. **(h)** section (25120-A). All FMNH UC. × 10.

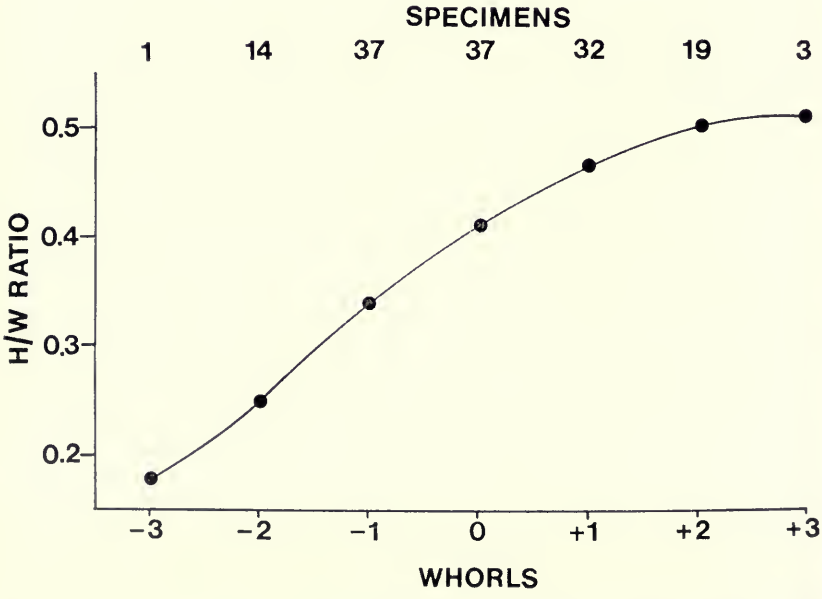


FIG. 95. Curve showing average height to width ratio for 37 specimens of *Meekospira evansvillensis* n. sp.

TABLE 59.—Measurements (in mm.) of *Meekospira evansvillensis* n. sp.

Specimen FMNH UC	H	W	Hs	Hf	Pa	Nw	Pw	H/W	Hf/Hs
25120-1	6.7	3.6	2.9	3.8	34°	5.0+	...	1.86	1.31
25120-2	6.1	3.0	2.7	3.4	34°	7.5	2.5	2.03	1.26
25120-3	5.1	2.9	2.1	3.0	39°	6.5	2.5	1.76	1.43
25120-4	5.3	3.2	...	...	31°	5.0+	...	1.66	....
25120-5	5.1	3.0	2.3	2.8	32°	7.0	2.0	1.70	1.22
25120-6	5.5	3.2	2.1	3.4	35°	6.0+	...	1.72	1.62
25120-7	5.3	2.9	2.1	3.2	32°	7.0	2.0	1.83	1.52
25120-8	4.6	2.6	1.9	2.7	35°	6.5	2.5	1.77	1.42
25120-9	4.3	2.4	1.9	2.4	35°	6.5	2.5	1.79	1.26
25120-10	4.3	2.5	1.7	2.6	35°	6.5	2.5	1.72	1.53
25120-11	4.1	2.5	1.7	2.4	39°	6.5	2.5	1.64	1.41
25120-12	4.8	2.8	2.0	2.8	35°	7.0	2.0	1.71	1.40
25120-13	2.9	2.2	1.0	1.9	42°	5.5	2.5	1.32	1.90
25120-14	4.1	2.7	1.7	2.4	28°	5.0+	...	1.52	1.41
25120-15	3.5	2.2	1.4	2.1	42°	5.5	2.5	1.59	1.50
25120-16	3.6	2.5	1.5	2.1	37°	5.0+	...	1.44	1.40
56378	6.5	3.7	2.8	3.5	35°	6.5	2.5	1.76	1.25
56379	5.9	3.1	2.7	3.2	34°	7.5	2.5	1.90	1.11
25043-3	4.6	2.7	1.9	2.7	36°	6.5	2.5	1.70	1.42
25043-4	4.2	2.4	1.8	2.4	33°	6.5	2.5	1.75	1.33
25043-5	3.6	2.3	1.5	2.1	36°	6.5	2.5	1.57	1.40
25043-6	4.0	2.6	1.6	2.4	35°	6.5	2.5	1.54	1.50
25043-7	3.9	2.4	1.5	2.4	40°	6.5	2.5	1.63	1.40
25043-8	3.6	2.4	1.4	2.2	40°	6.0	2.0	1.50	1.57
25043-9	3.4	2.1	...	...	...	5.0+	...	1.62	....
25043-10	2.8	2.0	0.9	1.9	42°	5.5	2.5	1.40	2.11
25043-11	2.7	1.9	0.8	1.9	43°	5.5	2.5	1.42	2.38
25043-12	2.7	1.9	0.9	1.8	40°	5.5	2.5	1.42	2.00
25043-13	2.3	1.9	0.8	1.5	41°	4.5	2.5	1.21	1.88
30486-1	5.1	2.9	2.0	3.1	35°	6.5	2.5	1.76	1.55
30486-2	3.8	2.5	1.5	2.3	30°	5.5	2.5	1.52	1.53
30486-3	4.4	2.8	1.6	2.8	37°	6.5	2.5	1.57	1.75
30486-4	3.9	2.3	1.6	2.3	32°	6.5	2.5	1.70	1.44
30486-5	3.9	2.5	1.3	2.6	35°	6.5	2.5	1.56	2.00
30486-6	3.4	2.2	1.1	2.3	35°	5.5	2.5	1.55	2.09
30486-7	3.0	2.0	1.0	2.0	33°	5.5	2.5	1.50	2.00
30486-8	2.9	2.0	1.0	1.9	38°	5.0	1.5	1.45	1.90
30486-9	2.1	1.7	0.8	1.3	41°	5.0	1.5	1.24	1.63
30486-10	1.8	1.5	0.5	1.3	39°	4.5	1.5	1.20	2.60
25119-1	5.2	3.0	2.0	3.2	30°	6.5	2.5	1.73	1.60
25119-2	4.6	2.9	1.9	2.7	30°	6.5	2.5	1.59	1.42
25119-3	4.1	2.6	1.6	2.5	36°	6.0	2.5	1.58	1.56
25119-4	4.1	2.5	1.6	2.5	35°	6.0	2.5	1.64	1.56
25119-5	2.0	1.5	0.8	1.2	...	4.5	2.5	1.33	1.50
N	44	44	42	42	42°			44	42
Total	179.8	110.5	67.9	103.0	1516°			70.40	67.81
Mean	4.09	2.51	1.62	2.45	36°			1.60	1.62
S.D.	1.18	0.50	0.79	0.61	...			0.18	0.10
S.E.(m)	0.18	0.08	0.12	0.09	...			0.03	0.02

Corr. coeff. between H and W = +0.938

Corr. coeff. between Hs and Hf = +0.925

TABLE 60.—Measurements (in mm.) of aperture of *Meekospira evansvillensis* n. sp.

Specimen FMNH	Ha	Wa	Ha/Wa
25120-8	2.0	1.3	1.55
25120-11	1.6	1.2	1.33
25120-13	1.5	1.1	1.36
56378	2.3	1.5	1.53
56379	2.1	1.5	1.40
25043-3	1.9	1.4	1.36
25043-10	1.4	0.9	1.56
30486-3	1.8	1.3	1.39
25119-1	2.1	1.4	1.50
25119-2	1.8	1.3	1.39
25119-3	1.7	1.2	1.42
Total	20.2	14.1	15.79
Mean	1.84	1.28	1.44

spiral basal ornamentation. Height of final whorl greater than height of the preceding spire. Whorl profile between sutures very slightly convex, but with a very narrow area or flattened zone just below the suture; sutures shallow. Protoconch simple, dextral, consisting of about 1½, or more usually, 2½ convex whorls. Base rather sharply rounded, anomphalous. Aperture moderate in size, higher than wide. Columellar lip straight and slightly reflexed. Parietal lip which is gently inclining about 45 degrees with the horizontal; parietal inductura apparently very thin and restricted to the lower portion of the lip. Outer lip slightly convex above, more convex below. Ornament consisting of about 8 to 18 basal spiral lirae which are rounded and separated by narrower spaces. Growth lines extremely faint, swinging forward above, but changing to strong backward swing below and on the base. Shell appears thin and not composed of two distinct layers (fig. 94h). The whorls are somewhat rhombic, but are without an indication of an anterior canal.

Comparisons.—*M. evansvillensis* n. sp. differs from other Carboniferous species by its very small size, large pleural angle, more rounded base, and basal spiral ornament.

Discussion.—The large number of specimens makes a statistical study of this species possible. The results are given in Tables 59–61. Comparisons of the specimens suggest the presence of both immature and supposedly mature individuals. This conclusion was tested by constructing an average ontogenetic growth curve for this species (see table 61 and fig. 95). The result indicates the presence of well-matured individuals. Therefore, the smallness of the specimens reflects genetic factors rather than immaturity.

TABLE 61.—Measurements (in mm.) of each whorl of *Meekospira evansvillensis* n. sp.

Specimen FMNH UC		Whorl No.							
		−4	−3	−2	−1	0	+1	+2	+3
	H	.....	.....	.....	0.400	0.500	0.700	1.100	1.500
25120-2	W	.....	.....	.....	0.900	1.200	1.800	2.300	2.900
	H/W	.....	.....	.....	0.444	0.417	0.388	0.478	0.517
	H	.....	.....	0.200	0.300	0.500	0.800	1.200	.....
25120-3	W	.....	.....	0.600	1.000	1.300	1.700	2.300	.....
	H/W	.....	.....	0.333	0.300	0.385	0.471	0.522	.....
	H	.....	0.050	0.200	0.400	0.500	0.800	1.000	.....
25120-5	W	.....	0.300	0.600	0.900	1.300	1.700	2.100	.....
	H/W	.....	0.167	0.333	0.444	0.385	0.471	0.476	.....
	H	.....	.....	.....	0.300	0.500	0.800	1.200	.....
25120-6	W	.....	.....	.....	0.900	1.300	1.600	2.200	.....
	H/W	.....	.....	.....	0.333	0.385	0.500	0.545	.....
	H	.....	.....	.....	0.400	0.500	0.900	1.200	.....
25120-7	W	.....	.....	0.600	1.000	1.300	1.700	2.200	.....
	H/W	.....	.....	.....	0.400	0.385	0.529	0.545	.....
	H	.....	.....	.....	0.300	0.500	0.700	1.000	.....
25120-8	W	.....	.....	.....	0.800	1.000	1.400	1.900	.....
	H/W	.....	.....	.....	0.375	0.500	0.500	0.526	.....
	H	.....	.....	0.300	0.400	0.500	0.900	.....	.....
25120-9	W	.....	.....	0.800	0.100	1.400	1.900	.....	.....
	H/W	.....	.....	0.375	0.400	0.375	0.474	.....	.....
	H	.....	.....	0.300	0.400	0.500	1.000	.....	.....
25120-10	W	.....	.....	0.800	1.000	1.400	1.900	.....	.....
	H/W	.....	.....	0.375	0.400	0.357	0.526	.....	.....
	H	.....	.....	0.100	0.300	0.500	0.700	1.200	.....
25120-11	W	.....	.....	0.600	0.900	1.200	1.700	2.100	.....
	H/W	.....	.....	0.167	0.333	0.417	0.412	0.571	.....
	H	.....	.....	.....	0.300	0.500	0.900	1.200	.....
25120-12	W	.....	.....	.....	0.900	1.300	1.700	2.300	.....
	H/W	.....	.....	.....	0.333	0.385	0.529	0.522	.....
	H	.....	.....	0.200	0.400	0.500	0.800	.....	.....
25120-13	W	.....	.....	0.500	0.900	1.300	1.700	.....	.....
	H/W	.....	.....	0.400	0.444	0.385	0.471	.....	.....
	H	.....	.....	.....	0.300	0.500	0.700	0.900	1.400
56378	W	.....	.....	0.400	0.800	1.100	1.500	2.000	2.900
	H/W	.....	.....	.....	0.375	0.455	0.467	0.450	0.483
	H	.....	.....	.....	0.300	0.500	0.800	1.000	1.500
56379	W	.....	0.200	0.500	0.900	1.200	1.600	2.100	2.900
	H/W	.....	....	.....	0.333	0.417	0.500	0.476	0.517
	H	....	.....	.....	0.300	0.500	0.700	0.900	....
25043-3	W	.....	.....	0.500	0.900	1.100	1.600	2.000	.....
	H/W	.....	.....	.....	0.333	0.455	0.438	0.450	.....
	H	.....	.....	.....	0.200	0.500	0.700	1.100	.....
25043-4	W	.....	....	0.500	0.800	1.100	1.600	2.000	.....
	H/W	.....	.....	.....	0.250	0.455	0.438	0.550	.....
	H	....	.....	.....	0.100	0.300	0.500	0.800	.....
25043-5	W	.....	.....	0.200	0.500	0.900	1.300	1.800	.....
	H/W	.....	.....	.....	0.200	0.333	0.385	0.444	.....
	H	.....	.....	.....	0.400	0.500	0.700	1.000	.....
25043-6	W	.....	.....	0.600	0.900	1.200	1.600	2.000	.....
	H/W	.....	.....	.....	0.444	0.417	0.438	0.500	.....

TABLE 61.—Measurements (in mm.) of each whorl of *Meekospira evansvillensis* n. sp.—*Continued.*

Specimen FMNH UC		Whorl No.							
		−4	−3	−2	−1	0	+1	+2	+3
	H	.....	.....	0.050	0.300	0.500	0.600	1.000	.....
25043-7	W	.....	.....	0.500	0.800	1.100	1.500	2.000	.....
	H/W	.....	.....	0.100	0.375	0.455	0.400	0.500	.....
	H	.....	.....	0.100	0.400	0.500	0.800	.....	.....
25043-8	W	.....	0.200	0.600	1.200	1.200	1.600	.....	.....
	H/W	.....	.....	0.167	0.400	0.417	0.500	.....	.....
	H	.....	.....	.....	0.300	0.500	0.800	.....	.....
25043-10	W	.....	.....	0.500	0.900	1.300	1.700	.....	.....
	H/W	.....	.....	.....	0.333	0.385	0.471	.....	.....
	H	.....	.....	.....	0.200	0.500	0.700	.....	.....
25043-11	W	.....	.....	0.500	0.900	1.100	1.500	.....	.....
	H/W	.....	.....	.....	0.222	0.455	0.467	.....	.....
	H	.....	.....	.....	0.200	0.500	.....	.....	.....
25043-12	W	.....	0.300	0.600	0.900	1.200	.....	.....	.....
	H/W	.....	.....	.....	0.222	0.417	.....	.....	.....
	H	.....	.....	.....	0.300	0.500	.....	.....	.....
25043-13	W	.....	.....	0.600	0.900	1.200	.....	.....	.....
	H/W	.....	.....	.....	0.333	0.417	.....	.....	.....
	H	.....	.....	0.100	0.300	0.500	0.800	1.000	.....
30486-1	W	.....	0.200	0.500	0.900	1.300	1.700	2.300	.....
	H/W	.....	.....	0.200	0.333	0.385	0.471	0.434	.....
	H	.....	.....	.....	0.300	0.500	0.900	.....	.....
30486-3	W	.....	.....	0.500	0.900	1.400	1.900	2.500	.....
	H/W	.....	.....	.....	0.333	0.357	0.474	.....	.....
	H	.....	.....	.....	0.300	0.500	0.800	.....	.....
30486-4	W	0.100	0.400	0.800	1.000	1.300	1.800	.....	.....
	H/W	.....	.....	.....	0.300	0.385	0.444	.....	.....
	H	.....	.....	.....	0.400	0.500	0.900	.....	.....
30486-5	W	.....	0.200	0.500	0.900	1.200	1.700	.....	.....
	H/W	.....	.....	.....	0.444	0.417	0.529	.....	.....
	H	.....	.....	.....	0.200	0.500	0.800	.....	.....
30486-6	W	.....	0.300	0.500	0.900	1.100	1.600	.....	.....
	H/W	.....	.....	.....	0.222	0.455	0.500	.....	.....
	H	.....	.....	.....	0.300	0.500	0.800	.....	.....
30486-7	W	.....	0.300	0.500	0.800	1.200	1.600	.....	.....
	H/W	.....	.....	.....	0.375	0.417	0.500	.....	.....
	H	.....	.....	.....	0.300	0.500	0.700	.....	.....
30486-8	W	.....	0.400	0.600	1.000	1.300	1.800	.....	.....
	H/W	.....	.....	.....	0.300	0.385	0.389	.....	.....
	H	.....	.....	.....	0.200	0.500	.....	.....	.....
30486-9	W	0.050	0.300	0.700	0.800	1.100	.....	.....	.....
	H/W	.....	.....	.....	0.250	0.455	.....	.....	.....
	H	.....	.....	0.100	0.300	0.500	.....	.....	.....
30486-10	W	.....	.....	0.700	0.700	1.100	.....	.....	.....
	H/W	.....	.....	0.142	0.428	0.455	.....	.....	.....
	H	.....	.....	0.100	0.300	0.500	0.800	1.200	.....
25119-1	W	.....	.....	0.700	0.100	1.300	1.900	2.500	.....
	H/W	.....	.....	0.142	0.300	0.385	0.421	0.480	.....
	H	.....	.....	0.100	0.300	0.500	0.700	1.100	.....
25119-2	W	0.050	0.300	0.600	0.900	1.200	1.700	2.300	.....
	H/W	.....	.....	0.166	0.333	0.417	0.412	0.478	.....

TABLE 61.—Measurements (in mm.) of each whorl of *Meekospira evansvillensis* n. sp.—*Continued.*

Specimen FMNH UC		Whorl No. −4	−3	−2	−1	0	+1	+2	+3
	H	.....	.....	0.100	0.300	0.500	0.600	1.000	.....
25119-3	W	.....	0.200	0.500	0.800	1.100	1.600	2.100	.....
	H/W	.....	.....	0.200	0.375	0.455	0.375	0.476	.....
	H	.....	.....	.....	0.400	0.500	0.800	.....	.....
25119-4	W	.....	.....	0.700	1.000	1.300	1.800	.....	.....
	H/W	.....	.....	.....	0.400	0.385	0.444	.....	.....
	H	.....	.....	0.200	0.300	0.500	.....	.....	.....
25119-5	W	.....	0.300	0.600	1.000	1.200	.....	.....	.....
	H/W	.....	.....	0.333	3.000	0.417	.....	.....	.....
N	H/W	0	1	14	37	37	32	19	3
Total	H/W		0.167	3.433	12.719	15.204	14.734	9.423	1.517
Mean	H/W		0.167	0.245	0.344	0.410	0.460	0.496	0.507
Corr. coeff. between H and W			.....	+0.62	+0.955	+0.647	+0.823	+0.770	.....

Measurements.—Measurements are given in Tables 59–61.

Material, stratigraphic position, and localities.—Sixty-nine specimens from three localities, many of them in almost perfect condition. Holotype FMNH UC 56378, one specimen FMNH UC 56379, one specimen FMNH UC 56380 and 16 specimens FMNH UC 25043, Lower Okaw (Marigold Oolite), Locality 14; one specimen FMNH UC 56381, one specimen FMNH UC 56382, 29 specimens FMNH UC 25120 and six specimens FMNH UC 25119, Lower Okaw (Evansville Oolite), Locality 3; 13 specimens FMNH UC 30486, Golconda Limestone, Locality 9.

Meekospira minuta S. Weller, 1916. Figure 96.

Meekospira minuta S. Weller, 1916, Cont. Walker Mus., **1**, no. 10, pp. 261–262, pl. 18, fig. 9.

Description.—Shell sharply acuminate, eulimiform, anomphalous with about nine volutions. Height of final whorl almost equals height of preceding spire. Whorl profile between sutures very gently convex; sutures shallow. Protoconch simple, dextral, consisting of about three convex whorls. Base rounded, extended and anom-

phalous. Aperture subovate, rounded anteriorly, pointing posteriorly. Columellar lip unknown; outer lip very slightly convex above and rounded below. Ornament absent.

TABLE 62.—Measurements (in mm.) of *Meekospira minuta* S. Weller, 1916.

Specimen FMNH UC	H	W	Hs	Hf	Ha	Wa	Pa	Nw	Pw
56383	15.3	5.7	7.6	7.7	5.1	2.7	27°	9	3

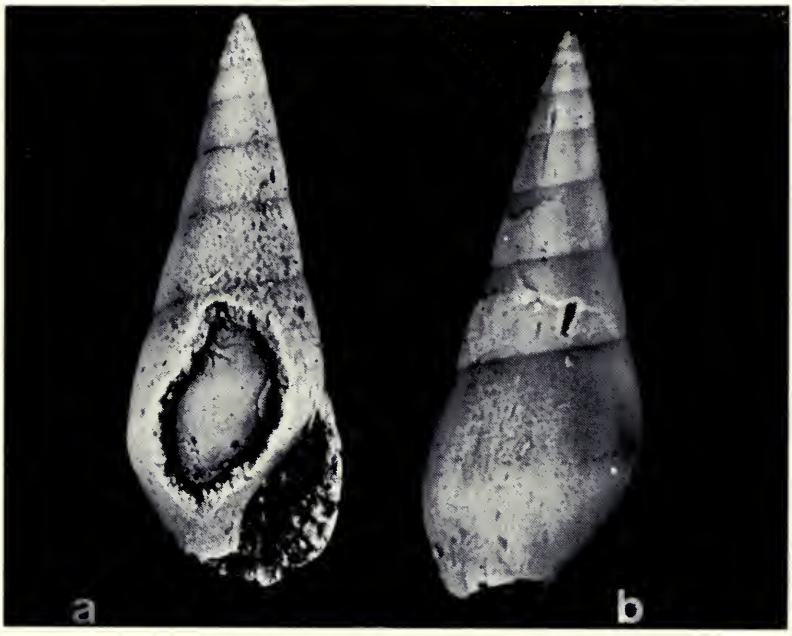


FIG. 96. *Meekospira minuta* S. Weller, 1916. **(a)** apertural view (FMNH UC 56383); **(b)** dorsal view, same specimen. All × 5.

Comparisons.—This species is intermediate in shape between *M. evansvillensis* n. sp. and *M. bambooformis* n. sp.

Measurements.—Measurements and ratios of measurements are given in Tables 62 and 63.

TABLE 63.—Ratios of *Meekospira minuta* S. Weller, 1916.

Specimen FMNH UC	H/W	Hf/Hs	Ha/Wa
56383	2.69	1.01	1.89

FIG. 97. *Meekospira mississippiensis* n. sp. **(a)** dorsal view of laterally compressed specimen (56385); **(b)** apertural view, same specimen; **(c)** apertural view of holotype (56384); **(d)** anterior dorsal view, same specimen; **(e)** dorsal view of laterally compressed specimen (56386); **(f)** apertural view, same specimen; **(g)** section (30490-A). All FMNH UC. All × 5.

TABLE 64.—Measurements (in mm.) of *Meekospira mississippiensis* n. sp.

Specimen FMNH UC	H	W	Hs	Hf	Ha	Wa	Pa	Nw	Pw
56384	13.8+	14.2	7.4	6.9	4.4	2.3	10°	8	3
56386	12.8	3.8	5.8	7.0	4.5	2.3	15°	9+	1+
30490-3	9.9+	3.8	4.7	5.2+	2.9+	1.4	...	7	3
56385	14.3+	5.4	...	...	5.0	3.1	13°	6+	..
30490-5	12.0+	4.0	...	...	3.8	2.1	11°	6+	..
30490-6	13.7+	4.3	...	...	3.6+	2.5	11°	6+	..
30490-7	9.0+	3.7	...	...	3.7	2.0	20°	4+	..
30490-8	8.4+	3.7	...	...	...	...	21°	4+	..
30490-9	6.8+	2.8	...	...	...	...	20°	4+	..

Material, stratigraphic position, and locality.—A single specimen FMNH UC 56383, Golconda Limestone, Locality 9. [Holotype FMNH UC 14870, Ste. Genevieve Limestone, Locality 48.]

Meekospira mississippiensis new species. Figures 9, 97.

Description.—Shell small, sharply acuminate, eulimiform, anomphalous, with about nine volutions. Height of final whorl generally slightly greater than that of the preceding spire; whorl profile between sutures very slightly convex, sutures shallow. Protonconch consisting of about three convex whorls. Base gently rounded and extended. Aperture moderately small, sublenticular in outline. Columellar lip arcuate, slightly reflexed. Parietal lip rather steeply inclined. Parietal inductura very thin, restricted to lower part of parietal lip. Outer lip gently convex. Ornament absent except for extremely faint growth lines. The shell appears very thin without two distinct layers; whorls lenticular.

Ontogeny.—The growth curve of *M. mississippiensis* n. sp. (fig. 9) is quite irregular. This may be due to the fact that most specimens are compressed laterally, and thus correct measurements of the width could not be obtained in spite of the attempt to approximate the width of whorls by averaging the maximum and minimum measures.

Comparisons.—This species differs from *M. evansvillensis* n. sp. and *M. bambooformis* n. sp. by its much larger size, from the former by its more extended base, and from the latter by its less slender shell.

TABLE 65.—Ratios of *Meekospira mississippiensis* n. sp.

Specimen FMNH UC	H/W	Hf/Hs	Ha/Wa
56384	3.40	0.93	1.91
56386	3.37	1.21	1.96
30490-4	....	....	1.61
56385	....	....	1.31
30490-7	....	....	1.85

This species also resembles the Pennsylvanian *M. peracuta* (Meek and Worthen, 1861), but is much more slender.

Measurements.—Measurements and ratios of measurements are given in Table 64–66.

TABLE 66.—Measurements (in mm.) of each whorl of *Meekospira mississippiensis* n. sp.

Specimen FMNH UC		Whorl No.						
		−3	−2	−1	0	+1	+2	+3
	H	....	....	0.80	1.00	1.40	2.00	2.90
56384	W	....	....	0.95	1.45	2.10	2.80	3.65
	H/W	....	....	0.84	0.69	0.67	0.71	0.79
	H	0.38	0.50	0.80	1.00	1.60	2.10	....
56386	W	0.68	0.90	1.23	1.68	2.30	2.85	....
	H/W	0.56	0.56	0.65	0.60	0.70	0.74	....
	H	....	0.45	0.60	1.00	1.30	1.80	....
30490-3	W	....	0.65	0.95	1.25	1.75	2.40	....
	H/W	....	0.69	0.63	0.80	0.74	0.75	....
	H	....	....	....	1.00	1.40	2.00	2.50
56385	W	....	....	....	1.65	2.30	2.93	3.60
	H/W	....	....	....	0.61	0.61	0.68	0.69
	H	....	....	0.50	1.00	1.20	1.90	2.20
30490-5	W	....	....	1.05	1.53	2.10	2.63	3.30
	H/W	....	....	0.48	0.65	0.57	0.72	0.67
	H	....	....	....	1.00	1.40	1.75	2.55
30490-6	W	....	....	....	1.50	1.98	2.63	3.25
	H/W	....	....	....	0.67	0.71	0.67	0.78
	H	....	....	....	1.00	1.55	1.95	....
30490-7	W	....	....	....	1.63	2.45	2.55	....
	H/W	....	....	....	0.61	0.63	0.76	....
	H	....	....	....	1.00	1.50	2.00	....
30490-8	W	....	....	....	1.73	2.35	3.05	....
	H/W	....	....	....	0.58	0.64	0.66	....
	H	....	....	0.83	1.00	1.45	....	....
30490-9	W	....	....	1.08	1.43	1.98	....	....
	H/W	....	....	0.77	0.70	0.73	....	....
N	H/W	1	2	5	9	9	8	4
Total	H/W	0.56	1.25	3.37	5.91	6.00	5.69	2.93
Mean	H/W	0.56	0.63	0.67	0.66	0.67	0.71	0.73

Note:—As the shells are compressed laterally, width of each whorl is made by averaging the maximum and minimum measurements.

Material, stratigraphic position, and locality.—Fifteen specimens from a single locality. Most are laterally compressed. Holotype FMNH UC 56384, one specimen FMNH UC 56385, one specimen FMNH UC 56386, and 12 specimens FMNH UC 30490, Golconda Limestone, Locality 9.

Genus **Girtyspira** Knight, 1936

Type species.—*Bulimella canaliculata* Hall, 1857.

Definition.—Shell small, fusiform; final whorl relatively high with a narrow subsutural ramp. Columellar lip arcuate.

Stratigraphic range.—Mississippian to Middle Permian.

American Mississippian species.—The following two species from Mississippian formations of the United States are referred to this genus:

Bulimella canaliculata Hall, 1857 (pp. 29–30, see Knight, 1941 pp. 129–130, pl. 92, figs. 4a–b), Salem Limestone, Indiana.

Solenospira pygmaea S. Weller, 1916 (pp. 256–257, pl. 18, figs. 1–5, 6), Ste. Genevieve Limestone, Illinois.

Girtyspira canaliculata (Hall, 1857). Figure 98.

Bulimella canaliculata. Hall, 1857, Adv. Trans. Albany Inst., **4**, pp. 29–30; Hall. 1864, Trans. Albany Inst., **4**, pp. 29–30.

Bulimorpha canaliculata. Whitfield, 1882, Bull. Amer. Mus. Nat. Hist., **1**, pp. 74–75, pl. 8, fig. 41; Hall, 1883, 12th Ann. Rept. Geol. Surv. Ind., p. 367, pl. 31, fig. 41; Keyes, 1889a, Proc. Acad. Nat. Sci. Phila., p. 300; Cumings, 1906, 30th Ann. Rep. Geol. Surv. Ind., pp. 1,343–1,344, pl. 25, fig. 41; Morse, 1911, Proc. Ohio State Acad. Sci., **5**, pp. 400–401, text-fig.

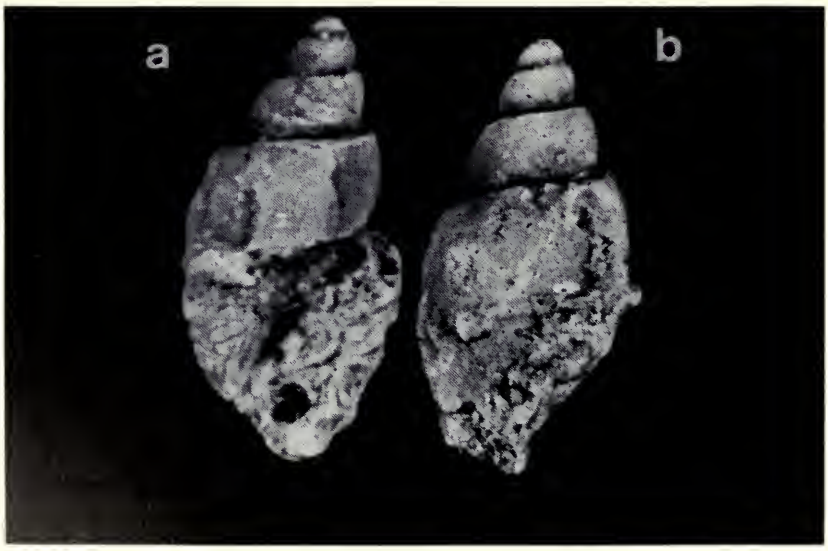


FIG. 98. *Girtyspira canaliculata* (Hall, 1857). **(a)** apertural view (FMNH UC 25036); **(b)** dorsal view, same specimen. All × 10.

25; Girty, 1915b, Bull. U.S. Geol. Surv., no. 544, p. 221; Snider, 1915, Bull. Okla. Geol. Surv., **24**, p. 116; Branson and Greger, 1918, Bull. Geol. Soc. Amer., **29**, pp. 322–323, pl. 19, fig. 15.

Description.—Shell high, fusiform, anomphalous, with shouldered whorls, an extended base, without anterior notch and columellar fold. Final whorl 3⅓ times as high as preceding spire. Whorl profile between sutures very gently arched, but having a narrow subsutural ramp. Suture angular above the ramp, but not deep. Protoconch rather smooth. Base much extended, anomphalous. Columellar lip arcuate, reflexed without anterior notch and folds. Parietal inductura seemingly wanting. Outer lip slightly convex, apparently rounded below. Ornament absent. Shell moderately thick.

Measurements (in mm.).—Height—5.7; width—2.9; height of spire—1.3; height of final whorl—4.4; height of aperture—2.7; width of aperture—1.8+; pleural angle—48 degrees; height/width—0.51; height of final whorl/height of spire—3.38.

Comparison.—This species differs from *Girtyspira pygmaea* (S. Weller, 1916), by its more robust form.

Material, stratigraphic position, and locality.—A single specimen FMNH UC 25036, Lower Okaw (Marigold Oolite), Locality 14.

Subclass Opisthobranchia Milne Edwards, 1848

Order Uncertain

Superfamily Pyramidellacea d'Orbigny, 1840

Family Streptacididae Knight, 1931

Genus **Donaldina** Knight, 1933

Type species.—*Aclisina grantonensis* Donald, 1898.

Definition.—Shell with convex whorls; ornament consists of spiral threads confined generally to lower two-thirds of each whorl, upper one-third apparently smooth. Columellar fold absent.

Stratigraphic range.—?Devonian, Mississippian to Lower Permian.

Discussion.—In the past, species of more than a single type have been assigned to *Aclisina* both in Europe and America. This confusion was resolved when Knight established the genus *Donaldina* (Knight, 1933b, pp. 57–58). At the same time, he pointed out that S. A. Miller had in 1889, validly designated *Murchisonia striatula* deKoninck, 1843, as the genotype of *Aclisina* deKoninck, 1881. This fact was overlooked by Longstaff (Miss J. Donald), in 1898 in Eng-

land, and also by other authors in the United States. Thus all of the species that Longstaff regarded as *Aclisina* together with most American species referred to that genus are now recognized as belonging to *Donaldina*. All of the species that Longstaff regarded as *Aclisoides* belong to *Aclisina*.

American Carboniferous species.—The following previously described species are referrable to *Donaldina:*

Aclisina bellilineata S. A. Miller (1891, p. 85, pl. 14, fig. 10; see also S. A. Miller, 1892, p. 695, pl. 14, fig. 10), Kinderhook Group, Missouri.

Ptychomphalus? *fountainensis* S. Weller (1916, p. 255, pl. 18, figs. 12–14), Ste. Genevieve Limestone, Illinois.

Solenospira pygmaea S. Weller (1916, p. 256, pl. 18, figs. 1–5, 6), Ste. Genevieve Limestone, Illinois.

Aclis robusta Stevens (1858, p. 259; Meek and Worthen, 1873, p. 596, pl. 29, fig. 6), Pennsylvanian of Illinois.

Turritella? *stevensana* Meek and Worthen (1866b, pp. 382–383, pl. 27, figs. 8, 8a), Pennsylvanian of Illinois.

Turbonilla swallowiana Geinitz (1866, p. 5, pl. 1, fig. 19), regarded as *Donaldina* by Knight (1933b, p. 58), is an *Aclisina* as shown by the selenizone situated at mid-whorl height at the center of the spiral ornamentation. In addition to the foregoing species, Elias (1958, pp. 17–21) reported the following species of *Donaldina* from late Mississippian Redoak Hollow Formation in southern Oklahoma:

Donaldina attenuata var. *ardmorensis* Elias, 1958.

Donaldina grantonensis (Donald, 1898).

Donaldina sp. cf. *D. tenuis* (deKoninck, 1881).

Elias' first two species are represented by very incomplete specimens, and the third is an external mold of a nearly complete spire. In spite of inadequate material, he compared his specimens with British Lower Carboniferous forms which he considered quite similar.

We disagree with Elias' opinion that *Solenospira pygmaea* S. Weller, 1916, is a synonym of *Donaldina* sp. cf. *D. tenuis*. S. Weller's specimens (18 specimens including six figured ones) do not correspond with Longstaff's description and illustrations of *Aclisina pulchra* var. *tenuis* deKoninck (see Donald, 1898, pp. 52–54, pl. 3, figs. 1–5). She stated that "the figure and description of deKoninck represent the various ornamentating threads as equal in strength, whereas in real-

ity on the lower part of the spire the three upper threads are finer than the four lower ones and there are several additional fine threads on the body whorl." (Donald, 1898, p. 52).

Solenospira pygmaea has an upper area less than one-third of the total whorl height, which is smooth and devoid of fine spiral threads. Below this there are only four to five spiral threads which are rounded rather than angular. There are only two spiral threads instead of numerous additional ones (Donald, 1898, p. 52, pl. 3, fig. 2) below the suture and on the base. In addition, the whorl profile is different. S. Weller's specimens are rather smoothly and narrowly rounded, and do not show an angulation beginning where the strong spiral threads make their first appearance.

Donaldina marigoldensis new species. Figures 99, 100.

Description.—Shells very small, with a little more than nine volutions. Whorl profile between sutures rather narrowly even, and more or less symmetrically rounded; earlier whorls gently convex. Sutures moderately deep and well-impressed. Aperture slightly higher than wide. Columellar lip straight, slightly reflexed. Parietal lip with thin inductura. Outer lip convex with slight anterior and posterior angulations. Ornament consisting of four spiral lirae on lower two-thirds of the whorls of spire, upper third smooth, except for two exceedingly faint lirae. Three to six additional spiral threads are present on the basal area of the last whorl. Growth lines very faint, concave on selenizone, rather strongly swinging forward below it, and convex on the base. Shell moderately thick.

Variation and ontogeny.—Only slight individual variation has been observed. Generally the less narrowly rounded whorls at comparable stages of development bear relatively stronger and more rounded spiral costae. The earlier whorls are more gently rounded than the later ones, and the pleural angle generally increases as maturity is reached. The average ontogenetic growth curve shown in Figure 100 indicates that maturity has been attained by some specimens.

Comparisons.—*Donaldina marigoldensis* closely resembles *D. pygmaea* (S. Weller, 1916), in form of whorls, but detailed comparison shows that it is less slender and its whorls are more sharply rounded. This species superficially resembles *D. stevensana* (Meek and Worthen, 1866), but can be distinguished by its more sharply rounded whorls. It also suggests *D. grantonensis* (Donald, 1898, p. 60, pl. 4, figs. 7–9), but has more sharply rounded whorls, fewer spiral costae

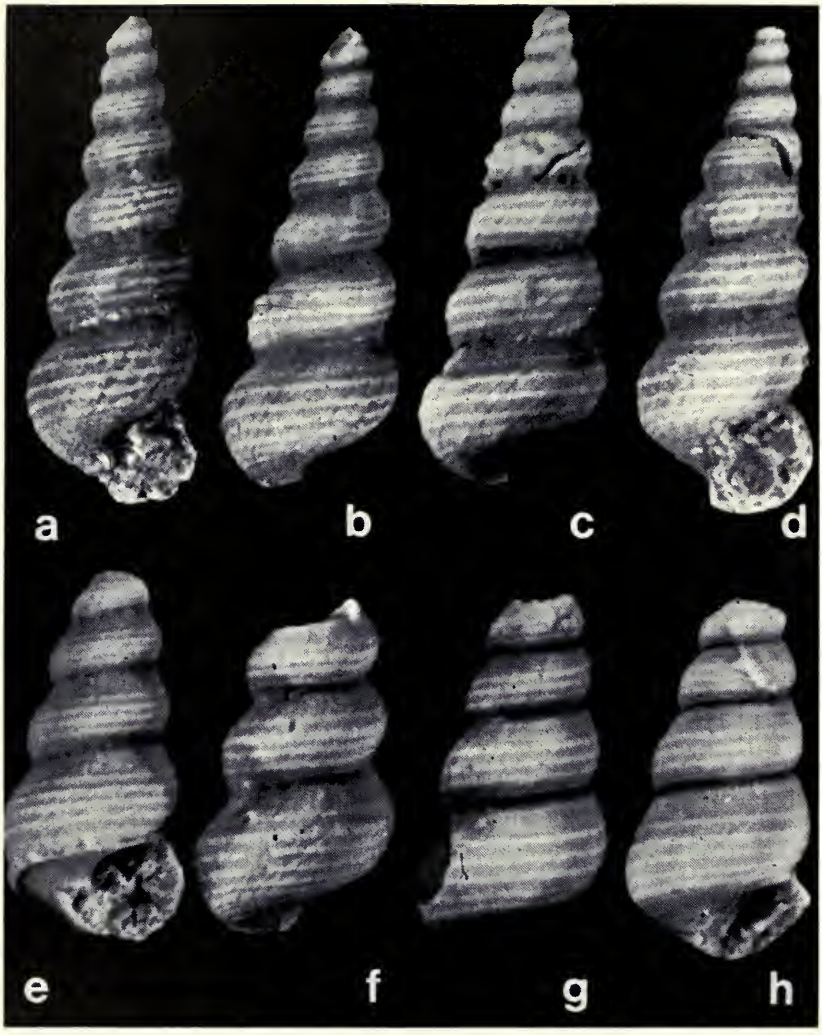


FIG. 99. *Donaldina marigoldensis* n. sp. **(a)** apertural view (56351); **(b)** dorsal view, same specimen; **(c)** dorsal view of holotype (56387); **(d)** apertural view, same specimen; **(e)** apertural view (56388-A); **(f)** dorsal view (56388-B); **(g)** dorsal view (56388-C); **(h)** apertural view, same specimen. All FMNH UC. All × 10.

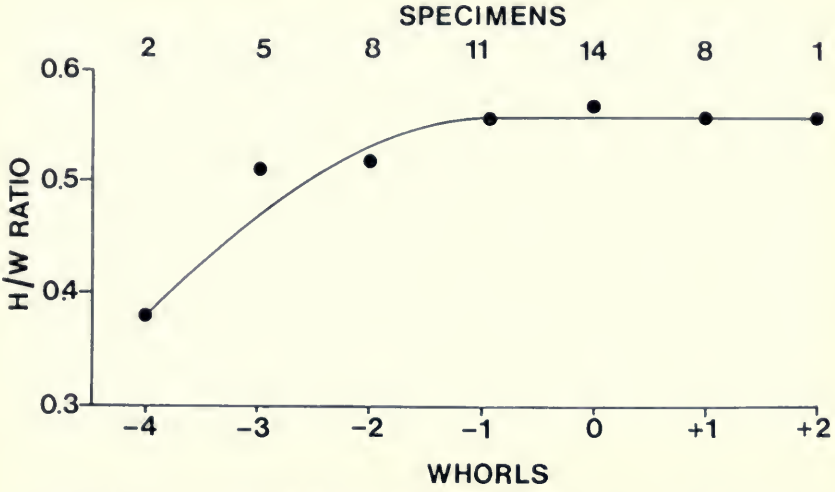


FIG. 100. Curve showing average height to width ratio for 14 specimens of *Donaldina marigoldensis* n. sp.

without intercalated second order spiral threads between them. Finally, it resembles *Aclisina swallowiana* (Geinitz, 1866), but the generic characters distinguish them.

Measurements.—Measurements are given in Tables 67 and 68.

Material, stratigraphic positions, and localities.—Seventeen specimens from three localities. Most are well-preserved although the protoconchs are variably broken. Holotype FMNH UC 56387, three specimens FMNH UC 56388, six specimens FMNH UC 25177, three specimens FMNH UC 25028 and two specimens FMNH UC

TABLE 67.—Measurements (in mm.) of *Donaldina marigoldensis* n. sp.

Specimen FMNH UC	H	W	Ha	Wa	Pa	Nw	Ha/Wa
56387	6.4+	2.4	1.3	1.2	17°	9+	1.08
25028-2	5.0+	2.5	1.3	...	19°	5+	....
56388-C	4.9+	2.5	1.5	1.4	19°	4+	1.07
56388-A	4.8+	2.5	...	...	16°	4+	....
56388-B	4.4+	2.6	...	...	19°	3+	....
25028-6	4.4+	2.1	...	...	18°	5+	....
25028-7	3.3+	1.9	1.0	0.8	19°	4+	1.25
56351	6.4+	2.4	...	...	16°	8+	....
25117a-1	9.0+	3.6	2.3	2.0	24°	7+	1.15
25117-2	5.6+	2.3	1.2	1.0	15°	7+	1.20
25117-3	4.8+	2.0	...	...	16°	7+	....
25117-4	4.6+	1.9	...	...	15°	6+	....
25117-5	4.5+	2.1	1.15	1.0	18°	5+	1.15
25117-6	4.3+	1.9	1.0	0.9	18°	6+	1.10

TABLE 68.—Measurements (in mm.) of each whorl of *Donaldina marigoldensis* n. sp.

Specimen FMNH UC		Whorl No.						
		−4	−3	−2	−1	0	+1	+2
	H	0.30	0.40	0.55	0.65	0.90	1.00	....
56387	W	0.70	0.85	1.00	1.40	1.75	2.00	....
	H/W	0.43	0.47	0.55	0.46	0.51	0.50	....
	H	....	....	....	....	0.90	1.00	....
25028-2	W	....	....	....	....	1.00	2.00	....
	H/W	....	....	....	....	0.90	0.50	....
	H	....	....	....	....	0.90	1.00	....
56388- A	W	....	....	....	....	1.70	2.00	....
	H/W	....	....	....	....	0.53	0.50	....
	H	....	....	....	0.80	0.90	1.15	....
56388-C	W	....	....	....	1.40	1.80	2.20	....
	H/W	....	....	....	0.57	0.50	0.52	....
	H	....	....	....	....	0.90	1.70	....
56388-B	W	....	....	....	....	1.00	2.05	....
	H/W	....	....	....	....	0.90	0.83	....
	H	....	....	....	0.70	0.90	1.00	....
25028-6	W	....	....	....	1.40	1.75	2.00	....
	H/W	....	....	....	0.50	0.51	0.50	....
	H	....	....	....	0.70	0.90	....	....
25028-7	W	....	....	....	1.40	1.70	....	....
	H/W	....	....	....	0.50	0.53	....	....
	H	....	0.50	0.60	0.72	0.90	1.10	....
56351	W	....	0.80	1.10	1.40	1.80	2.05	....
	H/W	....	0.63	0.55	0.51	0.50	0.54	....
	H	....	....	0.60	0.70	0.90	0.15	0.50
25177-1	W	....	....	1.00	1.40	1.70	2.05	2.70
	H/W	....	....	0.60	0.50	0.53	0.56	0.56
	H	0.20	0.35	0.50	0.70	0.90	....	....
25177-2	W	0.62	0.85	1.05	1.40	1.73	....	....
	H/W	0.32	0.41	0.48	0.50	0.52	....	....
	H	....	....	0.50	0.70	0.90	....	....
25177-3	W	....	....	1.14	1.48	1.75	....	....
	H/W	....	....	0.44	0.47	0.51	....	....
	H	....	0.50	0.60	0.80	0.90	....	....
25177-4	W	....	0.90	1.10	1.50	1.80	....	....
	H/W	....	0.56	0.55	0.53	0.50	....	....
	H	....	....	0.50	0.80	0.90	....	....
25177-5	W	....	....	1.00	1.30	1.70	....	....
	H/W	....	....	0.50	0.62	0.53	....	....
	H	....	0.40	0.50	0.70	0.90	....	....
25177-6	W	....	0.85	1.00	1.30	1.70	....	....
	H/W	....	0.47	0.50	0.54	0.53	....	....
N	H/W	2	5	8	11	14	8	1
Total	H/W	0.75	2.54	4.17	5.7	8.03	4.45	0.56
Mean	H/W	0.38	0.51	0.52	0.56	0.57	0.56	0.56

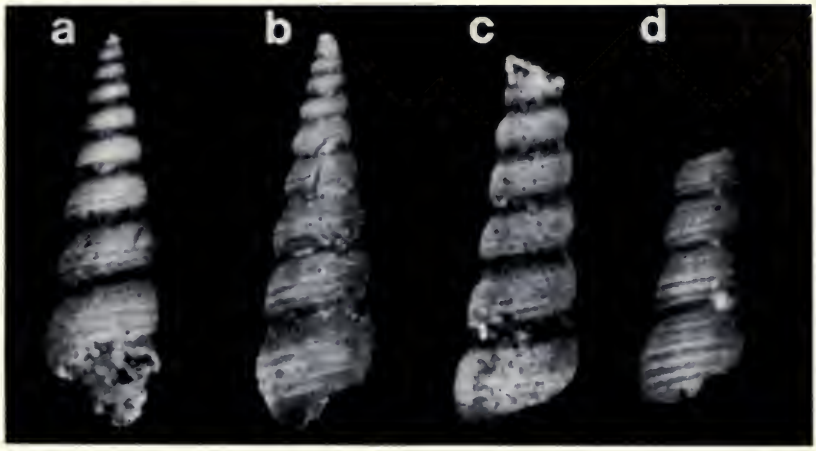


FIG. 101. *Donaldina americana* n. sp. **(a)** apertural view of holotype (25027); **(b)** dorsal view, same specimen; **(c)** dorsal view (56390); **(d)** dorsal view (56389). All FMNH UC. All × 10.

25030, Lower Okaw (Marigold Oolite), Locality 14; one specimen FMNH UC 56351, Lower Okaw (Evansville Oolite), Locality 3; and one specimen FMNH UC 25317, Lower Okaw Limestone, Locality 2.

Donaldina americana new species. Figures 101, 102.

Description.—The species is characteristically small, slender and composed of very gently rounded whorls, height not much less than width. Sutures strongly impressed. Columellar lip seemingly straight. Outer lip with posterior angulation, and probably anterior one also. Base rather gently and flatly rounded. Ornament consists of seven well-spaced spiral lirae, two very faint near the upper suture, and five lirae relatively stronger below. Additional lirae may occur on base. Growth lines very faint, swinging slightly forward below the selenizone. Shell moderately thick.

Ontogeny.—Ontogenetic growth curve of the species shown in Figure 102 indicates that full maturity has been attained by some specimens.

Comparisons.—*Donaldina americana* n. sp. differs from *D. marigoldensis* n. sp. by being more slender, with less sharply convex whorls. This species closely resembles *D. stevensana* (Meek and Worthen, 1866) (see Knight, 1931a, pp. 8–9, pl. 1, figs. 1a–g). Its whorl profile, however, is less flattened, the spiral lirae are fewer, and the shells are more slender with pleural angles of 12 to 13 degrees rather than 14.2 to 18.5 degrees. It resembles *D. aciculata* (Donald,

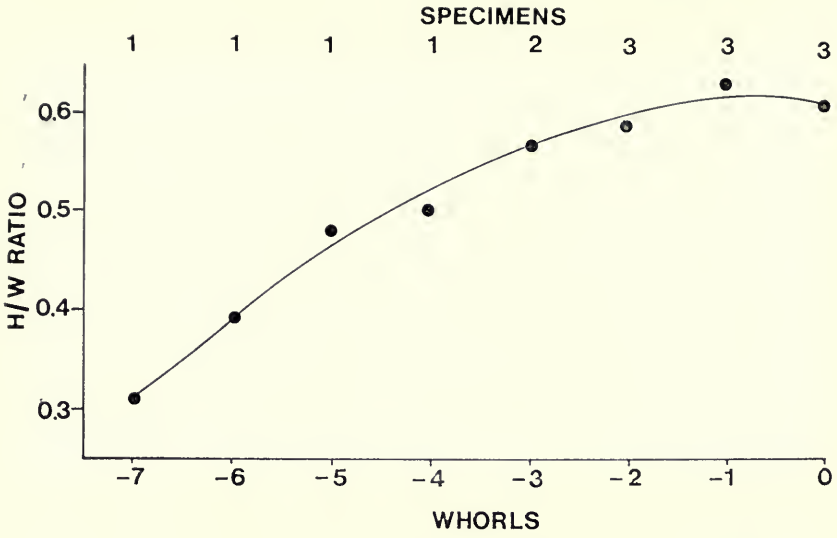


FIG. 102. Curve showing average height to width for three specimens of *Donaldina americana* n. sp.

TABLE 69.—Measurements (in mm.) of *Donaldina americana* n. sp.

Specimen FMNH UC	H	W	Hs	Hf	Ha	Wa	Pa	Nw	H/W
25027	5.2	1.7	3.2	2.0	....	....	14°	10	3.1
56389	5.0+	1.7	...	...	0.90	0.75	12°	7+	...
56390	3.3+	1.5	...	...	....	....	13°	4+	...

TABLE 70.—Measurements (in mm.) of each whorl of *Donaldina americana* n. sp.

Specimen FMNH UC		Whorl No.							
		−7	−6	−5	−4	−3	−2	−1	0
25027	H	0.13	0.20	0.30	0.40	0.50	0.56	0.80	0.90
	W	0.41	0.51	0.63	0.80	0.92	1.10	1.33	1.52
	H/W	0.31	0.39	0.48	0.50	0.54	0.51	0.60	0.59
56389	H	....	....	....	....	0.59	0.69	0.80	0.90
	W	....	....	....	....	1.00	1.10	1.30	1.50
	H/W	....	....	....	....	0.59	0.63	0.62	0.60
56390	H	....	....	....	....	....	0.62	0.80	0.90
	W	....	....	....	....	....	1.00	1.17	1.40
	H/W	....	....	....	....	....	0.62	0.68	0.64
N	H/W	1	1	1	1	2	3	3	3
Total	H/W	0.31	0.39	0.48	0.50	1.13	1.76	1.90	1.83
Mean	H/W	0.31	0.39	0.48	0.50	0.57	0.59	0.63	0.61

1898, pp. 59–60, pl. 4, figs. 4–6), but is less elongated and its sutures are inclined less steeply. It is similar to *D. bellilineata* (S. A. Miller, 1891), but its whorls seem to be somewhat less rounded, and relatively longer between sutures. Finally it differs from *D. pygmaea* (S. Weller, 1916), by having more elongated whorls.

Measurements.—Measurements are given in Tables 69 and 70.

Material, stratigraphic positions, and localities.—Ten specimens from three localities. Holotype FMNH UC 25027 and one specimen FMNH UC 56389, Lower Okaw (Marigold Oolite), Locality 14; one specimen FMNH UC 56390 and one specimen FMNH UC 25021, Lower Okaw Limestone, Locality 49; and six specimens FMNH UC 25103, Lower Okaw (Evansville Oolite), Locality 3.

Donaldina zadoe new species. Figure 103.

Description.—Shell high, somewhat obtuse with flattened base, and about eight volutions. Whorl profile between sutures gently convex. Sutures not deep. Aperture not well known. Columellar lip seemingly slightly arcuate. Ornamented with four spiral costae on whorls of spire, equally spaced, very gradually increasing in strength from first to third; the fourth being almost equal in strength to the third. Two additional costae occur on base of last whorl. Growth lines fine, swinging backward above selenizone, convex to lower suture, unknown on base of the last whorl. Shell moderately thick.

Comparisons.—This differs from other species of *Donaldina* by having a relatively low spire, flattened base, and equally spaced

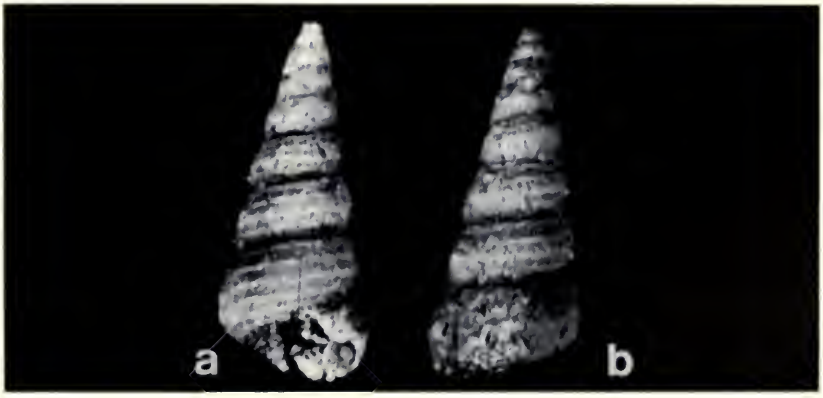


FIG. 103. *Donaldina zadoe* n. sp. **(a)** apertural view of holotype (FMNH UC 56391); **(b)** dorsal view, same specimen. All × 5.

spiral lirae on the whorls. The most similar species is *D. robusta* (Stevens, 1858), but the latter has a rounded base and more numerous lirae.

Measurements.—Measurements are given in Table 71.

TABLE 71.—Measurements (in mm.) of *Donaldina zadoe* n. sp.

Specimen FMNH UC	H	W	Hs	Hf	Pa	Pw	H/W	Hs/Hf
56391	9.4	3.9	5.7	3.7	15°	8.5+	2.4	1.54

Material, stratigraphic position, and locality.—Two specimens from a single locality. One is fairly well preserved and the other is compressed laterally. Holotype FMNH UC 56391, and one specimen FMNH UC 56392, Golconda Limestone, Locality 9.

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